Phycological Bulletin

No. 5

MAY 1957

Issued by
The British Phycological Society

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THE BRITISH PHYCOLOGICAL SOCIETY

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BRITISH PHYCOLOGICAL BULLETIN

No. 5 MAY 1957

Honorary Editor:

Elsie Conway,
Department of Botany,
University of Glasgow.

(with the assistance of Dr Betty Moss)

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EDITORIAL

The issue of this number, the fifth, of Phycological Bulletin continues the pattern of reporting the activities of the British Phycological Society followed in earlier numbers. The amount of material for publication reaching the Editor increases each year, reflecting in a most gratifying manner the activity of members and the growth in stature of the Society. The general policy of the Bulletin is kept under frequent review by the Council of the Society, and during 1956 two decisions were taken of which it is felt members would wish to know.

In the first place, in view of the extensive lists of algal literature now being published in the News-letter of the American Phycological Society, it seems redundant that British workers should undertake similar work; and so the publication of lists of recent papers which was begun in Bulletin no. 4 will not be continued. A system of exchange has been arranged between the editors of the journals of the American and British Phycological Societies, and the American Phycological News-letter will be available for reference at meetings of our Society.

Secondly, Council accepted a suggestion that the Bulletin should make provision for printing letters from members on topics of algological interest which may not, in themselves, be worthy of full-scale papers. The first of such letters are printed in the present number, and it is hoped that many members will follow the good start given. Letters may be on any topic of general phycological interest, requests for research material or even appeals for help with unsolved problems. Further, it is hoped that through the medium of the Bulletin members will offer information about unusual publications of which they know and which may be of interest or help to others. Short notices or reviews will be welcomed by the Editor at any time.

Under the Council's scheme whereby libraries may purchase copies of the Bulletin, 19 libraries of home and overseas universities and research institutes are now subscribers. All these have received full sets of Bulletins; but as earlier numbers are becoming rather scarce, any member who knows of a library which is contemplating taking advantage of the scheme is urged to advise early application: the time is fast approaching when numbers earlier that the current one will not be available.

* RECENT ADVANCES IN SEAWEED UTILISATION - AGAR, CARRAGEENIN AND ALGIN.

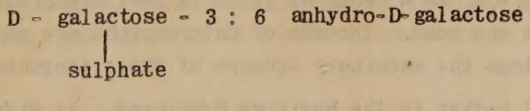
by Lily Newton.

It is now seven years since I tried to outline the current position of seaweed utilisation against an historical background, dating back to 300 B. C. (Newton, 1951). Since then I have had the opportunity of seeing some of the work in other parts of the world and have tried to collect further facts about seaweeds of commercial importance or of potential importance in this country and overseas. It would seem therefore that the time is ripe for a review of the present position, particularly in regard to agar, carrageenin and alginate, for all of which, and particularly the last two, industry is continually finding new uses.

Though I have restricted myself to these three substances and the algae which yield them, you will not need to be reminded that work proceeds in many other fields, systematic, cytotaxonomic, physiological and bio-chemical, on algae that are or may prove to be of industrial importance. The use of the electron microscope for the study of the cell-wall may well prove of especial importance in a group where the constituents of the wall are the source of extracts that are used commercially. New problems, like the disposal of radio-active waste, enforce a consideration of the mechanism by which iodine is taken up by the algae from seawater, and papers contributed at the Second International Seaweed Symposium at Trondhjem in 1955, when representatives of 21 nations gathered to discuss current algal research in its widest sense, emphasise the magnitude and diversity of the field in which we labour. A glance at recent algal bibliographies published in America and Canada make it clear why I have restricted myself to three products and have made no attempt to spread a wider net.

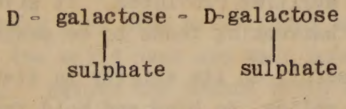
Let me try, first of all, to say something about the substances agar and carrageenin and the differences between them. It is important to realise that the work of recent years, particularly in the Atlantic Regional Laboratory in Nova Scotia, has greatly clarified the chemical differences between these substances. The strength of the gel of the extract is a very important factor in utilisation and in order to control that, a knowledge of the structure of the molecules was essential. The fact that there were important differences of gelation in hot and cold water extracts of *Chondrus crispus* has long been known, but recent work by Smith, O'Neill and Perlin (1955), and also by Goring and Young (1955) has elucidated the chemical differences between them. The cold extract consists mainly of lambda carrageenin and the hot of kappa carrageenin. The structural disaccharide units may be represented thus:-

Kappa carrageenin



$$\underset{\text{sulphate}}{\text{D - galactose}} - 3:6\ \text{anhydro-D-galactose}$$

Lambda carrageenin



$$\underset{\text{sulphate}}{\text{D - galactose}} - \underset{\text{sulphate}}{\text{D-galactose}}$$

The presence of potassium ions causes potassium carrageenin to gel or to precipitate at low concentration. Sodium carrageenate will not gel in this way.

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* This paper, read before the Society on January 3rd 1957, reports the second Presidential Address to be presented to the Society.

Agar is also a galactan sulphate, though the amount of sulphate present has long been in question. It was known to contain anhydro-galactose but the amount was not determined. However a paper by O'Neill and Stewart (1956) establishes that agar from *Gelidium cartilagineum* is D - Galactose - 3 : 6 anhydro - L - galactose, with a sulphate group on every 10th unit of the D galactose. Agar is thus quite similar to Kappa carrageenin, except that it is much less sulphated and contains anhydro-L-galactose with a sulphate group on every 10th unit of the D-galactose. The difference in the sulphate present is shown in the following table:-

	K Car.	Car.	Agar
Sulphate SO_3NA	28.0%	37.9%	4.1%
Anhydro-galactose	24.0	-	38.1
D-galactose	38.5	46.0	53.5

These essential chemical differences were a cause of difficulty in the provision of agar in World War II.

Carrageenin.

Commercially, carrageenin is one of the most important of the red seaweed extract. It can be derived from Gigartina species, but by far the largest quantity is extracted from *Chondrus crispus.* One firm is producing carrageenin in Norway, using mostly imported material from Eire. The centre of manufacture however is in America though most of the raw material is imported from France, Eire, Portugal and - in greatest quantity - from the Maritime Provinces of Canada. Some is obtained from the New England Coast. In Canada the harvest has increased considerably, having more than quadrupled in the decade 1943-52, and having increased from 10,000 lbs. in 1940 to over 4 million in 1953.

In 1955, 3½ million lbs. dry weight were harvested from Nova Scotia alone. The 1953 value of the raw material was near 500,000 dollars so that the importance was sufficient to stimulate research and further investigational surveys.

Chondrus is so abundant in the Maritime Provinces of Canada that it can be harvested with wooden rakes with broad close curved teeth, used either from the shore or from a boat. In Prince Edward Island immense quantities are washed up and can be harvested if they are collected rapidily. It is dried and transported to America for extraction, usually unbleached. The plants growing near and below L.W.M. to a depth of 12 or 14 feet are preferred because they are less contaminated with epiphytes and sand. Threads of Enteromorpha are especially difficult to eradicate and their presence clogs the machinery because of their toughness when dry.

Gigartina has only a small market in the Maritime Provinces. It gives a lower yield of carrageenin and commands a lower price though harvesting tends to be easier.

The numerous uses of carrageenin depend mainly on its ability to stabilise emulsions and foams, to form a medium for the suspension of solids, to bind and hold free moisture and to improve the texture of products, with the removal of harsh or sharp flavours. For these purposes it is used in a very wide range of trades in the food, textile, pharmaceutical, leather, brewery and other industries. New uses continue to come to light and recently the Research Division of the American Cyanamid Co. have found that carrageenin is a valuable hydrocolloid for maintaining the complete dispersal of aureomycin in ice. This is a matter of considerable importance and will be dealt with more fully later in connection with recent uses of alginate in the fish trade.

The fact that a very small amount of carrageenin is necessary to produce the desired effect is well known in the food industry, 1lb. added to 1,650 quarts of chocolate milk will bring about a permanent suspension. In ice too, the amount of carrageenin necessary to bring about dispersal of another ingredient is very small, often as little as 1 grm. in 6 litres of water.

The importance of carrageenin in industry and the use of Chondrus during the war in this country in an endeavour to produce a substance that could be used as agar has led to a continuation of research work on this very polymorphic alga.

C. MacFarlane (1952) has carried out experimental work in S.W.Nova Scotia on the recolonisation of harvested and denuded areas. She found that plants that had been sheared (leaving the holdfasts uninjured) or thoroughly raked without injuring the basal discs, recovered and reached the yield of the control after 18 months and 6 months respectively. In areas that were scraped and over-raked recovery took 20 months but if the area was completely denuded and the surface chipped away, there was a succession of temporary inhabitants, diatoms, delicate Chlorophyceae, Scytosiphon and then *Fucus vesiculosus* with *Chordaria flagelliformis.* As far as I am aware, the final result of this last part of the experiment is not yet published; but it was observed that after the severe winter of 1947-48 when ice denuded the rocks in the same area, the Chondrus did not increase markedly again until 1951, three-and-a-half seasons later.

The results of bad harvesting were comparable with those obtained for Chondrus by Lewis (Marshall, Newton and Orr, 1949) in Britain. They stress the need for care and conservation in commercial harvesting.

During our investigations of Chondrus for commercial harvest in Britain during the war, a number of problems presented themselves and some subsequent results have been obtained. Knoyle and Devonald (both unpublished) have made useful contributions to our knowledge of the fruiting periods. Devonald's graphs show sequence of cystocarpic development with a peak in summer, whereas the tetrasporic peak is in winter. He also showed there was a diminution in the respiration rate during fruiting and that a lower rate occurred in sub-littoral plants. In addition Devonald suspected that some of the so-called varieties were seasonal forms of the same plant. In order to elucidate this N.Jones has collected plants from a series of rock-pools from high to low-water mark over a period of 12 months. Though her results are not yet complete they suggest that *C. crispus* var. *nana* occurs only at the top of the littoral zone and that var. *stellatus* is only a seasonal form of var. *aequalis* and of the type.

Bio-chemical investigations continue particularly in the Atlantic Regional Laboratory in Canada under the direction of Professor E. Gordon Young and carrageenin seems assured of its place in a wide range of trades, as a 'tool' ingredient to alter with advantage the behaviour of other colloidal materials, particularly in the food industry.

Agar.

The uses of agar have long been established and its value in the food industry in Japan and in laboratory practice the world over are well known. There are, however, some facts which we may profitably consider. Before the Second World War Japan was collecting nearly 28 million lbs. of agar weeds annually from which about 9 million lbs. of agar was produced, using species of Gelidium, *Pterocladia tenuis, Acanthopeltis japonica,* Gracilaria sp. and *Campyraephora hypnaeoides.* Of these, Gelidium species were the most favoured as yielding the most satisfactory agar. Figures for the war years are not available but the most recent statistics published, show that only about 18 million lbs. of agar weed were harvested in 1954. I am informed from the University of Tokyo that the harvest of Gelidium has gradually decreased and that research work is in progress in order to try and increase the bulk available.

That interested me very much because of a phenomenon that I know to have occurred in New Zealand. During the war, an agar industry, which has survived, was established by Davis Gelatine (N.Z.) Ltd. at Christchurch in South Island, using mostly *Pterocladia lucida* and some of the finer *P. capillacea.* The export for 1953, 1954 and 1955 was something over 10 tons per annum, with an annual value approaching £28,000 (N.Z.). That of course is in addition to what was used in New Zealand. It compares well with Japanese agar and can be used for bacteriological work, as I myself saw in a Tasmanian hospital. Whilst in New Zealand I visited Aohanga where the greater part of the Pterocladia was collected. A flourishing collecting industry had been established there and weed was collected in great quantity from the drift. This had to be done immediately otherwise the next tide carried the cast weed to sea again. About 5 years ago the Pterocladia diminished in quantity at Aohanga and was finally so much depleted that the man whose industry had been so flourishing had to turn to another means of livelihood. The reason for the lack of Pterocladia and the future of the harvest are only conjecture. It does emphasise however the need for extensive research on the autecology of the algae of commerce.

Although during the 2nd world war many countries made agar, the practice has dropped to a large extent, except in Denmark where the figures for 1953 show a total nearly ¾ as large as that of Japan.. The Danish agar is made from *Furcellaria fastigiata* which floats in large quantities in parts of the Kattegat. The plants are mainly sterile and their mode of reproduction is being studied by A. Austin.

During my visit to Australia in 1950 I saw something of the river mouths and lagoons in which *Gracilaria confervoides* was harvested. Large quanties were dredged from places such as Sydney Middle Harbour where full salinity prevails, while other habitats yielding good harvests occurred in shallow lagoons of varying salinity or muddy brackish estuaries. The autecology of the plant in this country is being investigated by, E. W. Jones.

Though we know much more about the algae by these investigations, we are nevertheless a long way from seeing any way by which the plants can be cultivated. That again, is an aspect of algal utilisation that merits a great deal more investigation and experimental work. The difficulties are great but they ought not to be insurmountable in the fullness of time.

Alginic Acid (Algin).

The third substance with which I wish to deal is algin. The cell wall of the larger brown algae consists largely of cellulose and alginic acid. It is probably true to say that alginic acid is the most important colloid extracted from seaweeds commercially. It constitutes from 14 to 40% of the dry weight of the larger kelps and rockweeds, and varies seasonally, being highest in the colder months and lowest in summer. It has an empirical formula of $C_6 H_{10} O_7$ but its structure is not yet known completely, despite the researches of bio-chemists on both sides of the Atlantic. It is thought to consist of an unbranched long chain of B- d- mannuronic acid, joined by 1 : 4-glycosidic linkages. The substance is similar to cellulose and pectic acid, and is insoluble, but it forms salts, of which the sodium, potassium, lithium, magnesium, and ammonium alginates are soluble in aqueous media, the others are insoluble. When soluble, the salts are readily and quickly dissolved in water with the aid of high-speed stirrers and this is of great importance in some trades, such as textiles, where the alginate needs to be washed out after use.

Commercially, alginates are produced by a number of countries, from various seaweeds. One of the most important producers is America where Macrocystis is harvested from the Pacific coast and Laminaria sp. from the Atlantic.

Important work on Macrocystis, partly at any rate in relation to its possible use as a source of algin, has also been carried out by Australian workers. Womersley (1954) has outlined the circumsubantarctic distribution of the genus, showing that it is plentiful round most islands in the region and extends almost up to the equator in South America. In the northern hemisphere the genus occurs only off the west coast of America from about Magdalena Bay (California) to near Sitka in Alaska. In view of the occurrence of rich beds off the Australian and Tasmanian coasts, Cribb (1954), under the auspices of the C.S.I.R.O., has made an extensive study of *M. pyrifera* near Port Arthur. He found that if the terminal blade when detached had 50 cms. of stipe at the time of detachment, its growth rate was not impaired at any rate up to the two months of the experiment. Shorter lengths continued growth at a reduced rate though he thought that the rate might return to normal when the number of blades on the detached portion increased. The original plant however did not develop a new apical meristem at least up to 91 days after the cut was mde. From the point of view of possible large scale harvesting this is of course a point of the utmost importance. Although the blades laid down will mature after the apex has been detached the meristematic area has gone from the parent plant and only the meristem with a sufficient stipe can form new blades.

Although little if any processing is done in Canada, harvesting takes place and important surveys have recently been made by MacFarlane in South West Nova Scotia, with a view to increasing the Laminaria and Ascophyllum harvests. The weed is exported to America for extraction. Several interesting points emerge from the American and Canadian recent work. MacFarlane has shown that in harvesting Ascophyllum, not less than 6 or 7 inches should be left uncut and that the beds should not be harvested again for three years. This is in accord with the slow growth of Ascophyllum off the Welsh coast observed by David (1943).

In Britain, Laminaria and Ascophyllum are both used as sources of algin and *Laminaria Clouston*i is of especial importance. Though difference in the rigidity of a jelly will depend partly on the concentration of the alginates it is also dependent on the plant from which it was obtained. The stipe of *L. Cloustoni* yields especially rich gels, which is one reason for the importance of the huge casts of stipe that get washed up in the Hebrides in winter. Ascophyllum gel is much less rigid, but it has its uses in industry where semi-gels are needed or where extensible films are being produced.

In France the industry is small, but Laminaria is mainly used by three factories: 2 in Finistere and one in the Cotes-du-Nord (Thomas and Guillou, 1949). In Japan, *Ecklonia cava, Eisenia bicyclis* and some Laminaria and Sargassum species are regarded as yielders of alginic acid, and potential producers of sodium alginate, the total annual yield of which is approximately 430 tons. It is used mainly as dressing for textiles, for sizing paper, in the food trade and for medicine. While it is recognised that Laminarias yield the highest grade of alginate these plants are generally used for food in Japan and are therefore too highly priced to be used for alginate production. The cost of Sargassum weeds is low but so are their algin yields and in addition the alginate is regarded of inferier quality, both in viscosity and in colour, since bleaching is difficult. Ecklonia and Eisenia are widely distributed except in the Hokkaido region the price is low and the % yield of alginic acid is not very different from that of Laminaria.

In Chili some attempt has been made tq harvest *Durvillea antarctica* and *Lessonia nigrescens* for alginate production. E. Guiler in a private communication stated that he found the zonation appreciably affected by the removal of all the accessible Durvillea. I know of no research in this particular locality and I understand there was some trouble with the Lessionia extract.

Norway with its enormous coastline has paid considerable attention to its algal resources in recent years, both from the point of view of survey and alginate production. Grenager (1952-55) has published very substantial papers on the statistical study of the distribution and the ecology of the marine algae, especially the Laminarias and Ascophyllum. There are two firms manufacturing alginates. Although *L.Cloustoni* is the dominant species round Norwegian Coasts, the mean density being 14 kg. per sq.metre of which only 10% is *L.saccharina* with only a little *L.digitata*, yet the *L.Cloustoni* is not harvested commercially. It has been stated that unkown phenols prevent the production of a pure white powder, which is a necessity in the food trade. This is somewhat surprising as *L.Cloustoni* is favoured by at least one British firm. Taken as a whole, world alginic acid production amounts to over 1,000 tons annually and the substance is finding an ever-expanding use in industry.

The alginate radicle is non-toxic and therefore alginates are edible if they are combined with suitable bases. There is some evidence that sodium alginate and propylene glycol alginate can form part of the carbohydrate of the diet. Normally, however, much of an alginate remains undigested. It can in fact act as a bulk laxative. These facts enable alginates to be used increasingly in the food trade and two important developments of recent years have been their use in the stabilisation of ice lollies and in the manufacture of sausage skins. Apparently the skin can be the most costly part of a sausage, and in Britain, Germany and the U.S.A., sausage casings are now being made economically from alginates. The sale of ice lollies had increased very considerably in recent years and many of them are stabilised with alginate, in the same way as ice cream.

The use of alginates in the food and bakery trades continues, as well as in the manufacture of cosmetics, in the textile, leather, paper, paint and ceramics trades, in the stabilisation of creamed rubber latex and in the making of soluble films.

There are however some recent important developments. The rapidly increasing use of alginate in the fish trade merits consideration. Since the 2nd world war there has been an enormous rise in the production of processed fish particularly in America. From 1953-1955 the American figures for frozen packed fish rose from 109.6 million lbs. to 120.3 million lbs. of which 50 millon lbs. consisted of fish 'figures' or 'sticks'. One plant at St.Louis, Missouri, produces 20,000 fish fingers per hour from N.Atlantic Cod. It is of the greatest importance to the processer that the fish should be absolutely fresh, a fact which governs the time that the trawlers can remain at sea, unless there is some means of keeping the fish in perfect condition. Fishes with a high fat content tend to go rancid more quickly than those with a lower fat content and the storage of the herring represents the problem at its maximum. Research by A.S.Protan, a Norwegian firm, has shown that herrings can be embedded in an alginate solution before freezing, which forms a gel around the fish and prevents oxidation and rancidity. Salts can be added to the solution which lower its freezing point to 3° or 4°C below the fish, so that when the whole block is taken out, the jelly thaws and the fish remains frozen, making separation easy. The alginate has the additional advantage that it keeps the salts in uniform concentration, by adsorption.

The method has now been extended to small herring and sardines as well as to cod and other fillets that are so largely processed in America. In Norway 1,800 tons of fish were frozen by this method in 1955 as compared with 1½ tons in 1953.

In 1954, Sweden froze brisling with the addition of alginate, a special mixer dealing with 3 tons of fish per hour. Canning can take place 2 - 3 months after the initial storage, and so the canning season can be prolonged. A soft jelly which is quickly washed out after thawing can also be used for preserving shrimps. During the last whaling season, two companies froze whale meat in alginate jelly with great success.

A further point of interest in this connection is that the addition of a small quantity of aureomycin to the solution that is to be frozen is of great advantage for the preservation of the fish. In Britain the use of antibiotics for food preservation is not at present allowed, though I believe the matter is under consideration. I understand that the use of ice containing aureomycin is soon to be permitted in Canada and that it is already permitted in America. If an antibiotic is to be added, then the alginate plays a role of great importance. Aureomycin added to the water before freezing, tends to creep towards the centre of the ice block, moving no doubt along a heat diffusion gradient. The addition of alginate however causes the aureomycin to be adsorbed on to the surface of the colloid and to remain evenly disseminated through the block. in the same way that salts which were added to lower the freezing point in the case of herring preservation, were kept in uniform concentration, as mentioned earlier.

The use of alginate in ice for fish preservation appears therefore to have become an established and rapidly increasing practice for several reasons on both sides of the Atlantic. I believe that one American firm manufacturing aureomycin is proposing to incorporate carrageenin in their product 'Acronize' if its use is permitted by the food and drugs regulations. Carrageenin would act in a similar manner to alginate.

Alginates are also taking a more important place in clinical surgery. Higgins (1950) has shown that when calcium alginate wool is used as a swab, it is completely soluble and yields a viscous solution in which the bacteria contained in the swab are suspended and can be diluted. Percentage recoveries of *Staphyloccus aureus* gave a mean value of 90.7% as against 49.9% for cotton wood. *B. coli* gave a mean of 89.9% as against 67.0% for cotton wool.

Absorbable calcium alginate wool has also proved of great value in surgery (Blaine (1951), Oliver and Blaine (1950), Rumble (1949)) where it can be absorbed by the body without harmful effects, and it has a local haemostatic effect as well. If some of the calcium ions are replaced by sodium ions the rate of absorption can be increased. It is compatible with penicillin and can thus be used to prevent post-extraction haemorrhage in dentistry with great success. It is heat resistant and can be easily sterilised.

When used as a dressing, in the form of a loosley knitted gauze, calcium alginate not only arrests bleeding but provides a mesh in which the blood rapidly clots. Haemostasis may be accelerated by the release of calcium ions by the blood itself. A gelatine-like film is formed which protects the wound. The remaining calcium alginate material is readily dissolved in about 15 - 20 minutes in 4% sol. of sodium bicarbonate, so that delicate tissues, newly formed, are not torn, neither is the patient disturbed by the painful removal of a dressing. Healing is more rapid, to the benefit of both nurse and patient, (Bray, Blaine and Hudson (1948).

Looking back, over the algological field as a whole, I think that in the last decade the study of algology has received a stimulus, as is evidenced by the establishment of this Society, of comparable ones in France and America and by the establishment of a regular International Symposium. I think these facts are not unrelated to industrial needs and we all know quite well that science and industry need to work in double harness if the best use is to be made of the raw material. At the same time though industrial use is one end point, very much pure research has to be done, often without any awareness of, or apparent correlation with, industrial need. I greatly regret the cessation of the Government Grant for the support of the S.S.R.A. in Britain, because although devoted work is being done by individuals in Universities and Research Stations, we have no single place dedicated to marine algological research in the way that Ferry House has become a centre for fresh-water research, thanks to the wisdom of the late Professor Fritsch and of Professor Pearsall. The total world production of alginate alone is worth about two million pounds per annum and four British firms are producing about a quarter of that, which finds a market in some 30 countries. Britain has also at least four firms producing carrageenin so that we can at least be said to have an important place in the field of seaweed production. I hope that this Society will lose no opportunity of encouraging research, both pure and applied, and of urging the suitability of this country to be the international centre for algological investigation on this side of the Atlantic.

In conclusion I would like to express my thanks to all those who have so freely sent me information, and especially to Professor E. Gordon Young, Miss MacFarlane and Mr A. B. Cribb. I also acknowledge gratefully the exhibition material so kindly sent by British Alginates Ltd. and Messrs. Wallace Cameron.

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SUMMER MEETING AT DALE FORT FIELD CENTRE
SEPTEMBER 19th. - 26th. 1956.

From September 19th-26th, 1956, the Society held its summer field meeting at the Field Study Centre, Dale Fort, Pembrokeshire. Twenty-five members and ten students attended.

Wednesday, September 19th. Members were welcomed in the evening by Mr J.H. Barrett, the Warden of the Field Study Centre, and Professor Newton gave an introductory talk about the Dale area. Transport for the excursions was arranged, using members' cars. At Mr Barrett's request, it was agreed that, during the week, the species collected should be listed for incorporation in the records for South Pembrokeshire, at Dale Fort. It was decided that the same procedure should be used as at St. Bee's Head in 1955, and the same leaders agreed to check records and compile the lists, viz:- Chlorophyta: E.M. Burrows and P.S. Dixon, Phaeophyta: H. Blackler, Rhodophyta: K.M. Drew Baker, and Cyanophyta: H.T. and H.G. Powell. During the week most of the existing records for this part of South Pembrokeshire were confirmed and a number of new ones were added.

Thursday, September 20th. Mr Barrett led an excursion to Marloes Bay, a very exposed sandy bay on the west side of the Dale peninsula. A walk along the cliffs, after lunch, took the main party to West Dale Bay, where, on the more sheltered side, some good rock pools were found. A small party had returned to Dale Fort earlier for dredging in Dale Roads. We spent the evening in the laboratory working through material collected during the day.

Friday, September 21st. With Mr Barrett again leading, we went to St. Bride's Haven, a small more sheltered bay north of Marloes. The coast here appeared to be richer than the bays visited on Thursday. Specimens of *Saccorhiza polyschides* were found washed up.

Again a few members dredged in Milford Haven during the afternoon. It was interesting that their rich haul resembled, in general character, hauls in the Plymouth area rather than those in the vicinity of Port Erin.

In the evening Mr Barrett gave a most interesting lecture outlining the history and work of the Field Studies Council and his own varied and somewhat exacting work as Warden of a Field Studies Centre.

Saturday, September 22nd. The wet morning was spent in the laboratory, but a short excursion was made in the afternoon, about low tide, to St. Ann's Head. Two enterprising members made the steep descent to the rocky foreshore under the headland, while the rest took an easier path, by steps, to collect in Mill Bay. Heavy rain damaged our enthusiasm!

After dinner, in the absence due to illness, of the scheduled Speaker, Mr R. Williams, we were very pleasantly entertained by Mr Talling, who, at short notice, gave a talk, illustrated by beautiful colour photographs, taken on a hydrobiological trip down the River Nile from Lake Victoria to Cairo.

Sunday, September 23rd. Most of the party took the morning off and ate their picnic lunches in a variety of places. In the afternoon Mr Barrett conducted a party to the estuary tidal flats of the River Gann and showed us the only spot there where *Zostera* has been found growing. We saw large quantities of *Bostrychia scorpiodes, Fucus ceranoides* and of what appeared to be interesting *Fucus* hybrids.

We were fortunate that, in spite of very rough weather, it had been possible to fetch Dr Mary Gillham from Skokholm, and so we were able to enjoy, on Sunday evening, a lecture from her on the Ecology of Skokholm. She spoke particularly of her own researches into the effects of the animal population on the vegetation of the Island and made us all hope that the excursion planned for the next day would be possible.

Monday, September 24th. At last the weather relented and we had a wonderful day for our visit to Skokholm. The sun shone all the time and though the wind made the crossing a little rough most of us enjoyed the trip to the Island and we all enjoyed the time we spent there. We were welcomed by the warden, Peter Davis, who showed us a shearwater that had been caught in one of the nets, and then two storm petrel chicks from burrows he had under observation. Dr Mary Gillham took us on a tour of the Island and was able to demonstrate some of her work. There was time to collect algae before we joined the local inhabitants for our tea.

Tuesday, September 25th. We spent our last day on a conducted bus trip along the River Cleddau with stops at Little Millford, Llangwyn and Newland. There followed the usual hectic last evening of sorting specimens and clearing up the laboratory.

We owe thanks to our secretary for his very efficient organisation of the field meeting, and to Mr Barrett for making us so welcome at Dale Fort Centre.

K.M. CHALKLIN
M.A.P. MADGE.

FIFTH ANNUAL GENERAL MEETING: LONDON, 3rd JANUARY, 1957.

By kind permission of Professor C.T. Ingold, a one-day meeting of the Phycological Society was held in the Department of Botany, **Birkbeck College** (University of London), Malet Street, London, W.C.1, on Thursday, 3rd January 1957. Professor Ingold kindly made most of the local arrangements, and about 60 people attended the meeting. Through the kindness of the Warden (Miss A.M. Stephenson), 21 members were accommodated in the College Rooms of the Institute of Education (Univ. of London), at 36 Bedford Way, London, W.C.1.

The programme included: a **Presidential Address** from Professor L. Newton, followed by three other **papers**, all relating to work **on algae of economic importance**; a session of **Demonstrations**, and the **Fifth Annual General Meeting.**

At 10.30 a.m., Dr M.W. Parke (Vice-President) took the chair for the morning session and welcomed members and their guests to the meeting. Before starting her Presidential Address to the Society, Professor Newton expressed her appreciation of the hospitality shown by Birkbeck College to the Society that day, and also thanked the officers and members of the Phycological Society Council for their support during her two years of office as President. Professor Newton then gave her Address, **Recent Advances in Seaweed Utilisation**, which is reported (p.1) in the present Bulletin. Dr M.T. Martin then proposed a vote of thanks to Professor Newton for a most interesting and informative Address and also for her work on behalf of the Society during her term as President; the proposal was carried with warm acclamation. The following papers were then read (see authors' abstracts at end of this report):

1. W.E. Jones, Esq. (Marine Station, Bangor). Some aspects of growth and development in *Gracilaria verrucosa.*
2. A.P. Austin, Esq., (Marine Station, Bangor). Studies in the autecology and cytology of *Furcellaria fastigiata.*

The following members contributed to interesting discussions of these papers: Professor Newton, Dr Parke, Dr K.M. Drew Baker, Dr M.B.E. Godward.

Dr Parke thanked the speakers for their papers, and at 12.45 p.m. members adjourned for lunch at the College refectory.

At 2.00 p.m., Professor Newton took the chair and the following paper was read:

3. Dr T.I. Shaw (M.B.A., Plymouth). Iodide and the respiration of *Laminaria digitata*.

Professor Newton, Dr Delf and Dr Moss contributed to a discussion of this paper, and Professor Newton thanked the speaker. The next item in the programme was a short film that Professor Newton had obtained for the occasion, showing something of the commercial uses of seaweed products; the film was much appreciated.

Menbers then moved to another laboratory and spent the period from 2.45 p.m. - 4.00 p.m. examining a very fine series of demonstrations set up by members of the Society. Professor Newton, Mr Jones and Mr Austin had set out demonstrations to illustrate their papers, and other demonstrations were contributed as follows: cytology of *Spirogyra, Ulva, Enteromorpha, Cladophora* and *Chaetomorpha* (Miss M.A. Allen, Mr Y.S.R.K. Sarma and Mr J.P. Sinha, Queen Mary College, London); cytology of species of *Laminaria* (Dr M. Naylor, Hull University); some freshwater Rhodophyta (Mr. J.H. Belcher, University College, London, and Miss E.M.F. Swale, Birkbeck College, London). This was followed by tea in the Refectory.

THE FIFTH ANNUAL GENERAL MEETING started at 4.30 p.m., with the President (Professor L. Newton) in the chair. There were 40 members present.

MINUTES

1. **Letters from Members.** The Secretary reported that letters or messages had been received from Dr M.R. Droop, Mr E.A. George, Dr G.W. Lawson, Dr Lucy B. Moore and Miss Hilda Parkes - all regretting that they could not attend the present meeting and sending good wishes for its success.

2. **The Minutes of the Fourth Annual General Meeting,** held at Imperial College, London, on 4th January 1956, had been circulated to all members in Phycological Bulletin No. 4. The minutes were approved, and the Chairman signed the official copy.

3. **Report from Council:**

   (1) **Report of Hon. Secretary.** Mr H.T. Powell reported on the meetings and other activities of the Society during the year 1956 as follows:

   (a) **Meetings:** during the year two general Meetings of the Society were held - the one-day meeting at Imperial College, London (the Fourth A.G.M.) on 4th January (see full report in Bulletin No. 4); and the 7-day Field Meeting at Dale Fort Field Centre, in Pembrokeshire, September 19th-26th 1956.

   Only 25 members were able to attend the Field Meeting, which proved to be most successful and enjoyable. The Warden (Mr J.H. Barrett) and his staff, with their invaluable local knowledge, and their always patient attention to the many requirements and requests, did a great deal to ensure the success of the meeting.

   Several talks and lectures were given to members in the evenings by Professor Newton, Mr Barrett and Dr Mary Gillham, and these were much appreciated. Each day excursions were arranged to nearby shores, to estuaries and to the Gann salt-marsh, and from these visits members were able to obtain a good idea of the ecology of the marine algae of the district. Some interesting new records were made, of both marine and freshwater algae. A list of all the marine algae accurately identified is being compiled and will be published in Bulletin No. 5.

   The high-light of the meeting, at least for the Secretary, was the one-day excursion to Skokholm, led by Dr Gillham. We were blessed with unexpectedly fine weather for the boat trip to this small bird-sanctuary and spent a very interesting day ashore. Mr Peter Davies kindly showed us some of the work he is doing as Warden of the Bird Observatory, and Dr Gillham pointed out many interesting features of ecological interest. A fuller report of the Dale Fort meeting will appear in Bulletin No. 5.

(b) **The 1956 Council** met on **four** occasions, as follows: 4th January (Imperial College), 20th Sept. and 24th Sept. (Dale Fort), 3rd January 1957 (Birkbeck College).

(c) **Two Subcommittees** continue to function: (i) **The Subcommittee for Marine Algal Check-list and Flora** has met twice during the year. A number of members are actively working upon the various parts of the proposed new marine algal Flora, and some preliminary information has been obtained from possible publishers. It is now estimated that the times required for completion of the various volumes, on the present basis of working, are as follows: the volume on *Diatoms* is well on the way to completion; *Chlorophyta*, a minimum of 2 years; *Myxophyceae*, 3 to 4 years; *Phaeophyta*, less than 5 years; *Rhodophyta*, 5 years. As much help as possible in preparing species descriptions for the Floras is urgently needed from all members of the Society in order that publication may be achieved within these periods. Members are also asked again to send further completed Algal Record Cards to Dr Parke at Plymouth; the Society will bear the cost of replacing completed record cards. (ii) **The Subcommittee for Algal Nomenclature** has not had occasion to meet during the year. Mr Ross reports, however, that the Revised International Code of Botanical Nomenclature was published in December 1956 and is obtainable from the International Association for Plant Taxonomy, 106 Lange Nieuwstraat, Utrecht, Netherlands; Price 50/- (25/- to Association members).

(d) With regard to the "**Phycological Bulletin**", No. 4 (dated May 1956) was produced during the year and reported the activities of the Society and other matters up to the Fourth A.G.M. The cost of production of Bulletin No. 4 was approximately 3/9d. per copy posted to members. 24 libraries now subscribe to the Bulletin at the special rate for library membership (7/6 p.a.). Dr Betty Moss is now assisting Dr Conway with the production of the Bulletin. Dr Conway will report some recent Council decisions relating to the Bulletin under item 4 below.

(e) **The membership of the Society** is 102 at present (77 in Britain and Ireland; 25 overseas), compared with 99 a year ago. During the year 5 members resigned from the Society, but 8 new members have joined and we extend a warm welcome to them; the new members are Miss M.A. Allen (at Queen Mary College), Mr H.M. Burkill (Singapore), Mr V. Krishnamurthy (at Manchester), Miss Constance Macfarlane (Halifax, Nova Scotia), Mr J.D.A. Miller (University College, London), Mr Y.S.R.K. Sarma (at Queen Mary College, London), Mr J.P. Sinha (at Queen Mary College, London), and Miss E.M.F. Swale (Birkbeck College, London).

The report was adopted and Professor Newton moved a vote of thanks to the Secretary for his work on behalf of the Society during the year.

(ii) **Report of Hon. Treasurer.** Dr M.T. Martin explained the Income & Expenditure Account and the Balance Sheet for the year ended 1st November 1956, copies of which had been circulated to members beforehand (see copy at end of this report). Expenditure was exceptionally heavy because two Numbers of the Bulletin had been produced in the year; however, this still left a small surplus for the year (£6), and a healthy actual balance at the bank of nearly £160. 5 of the 9 subscriptions in arrear had been paid since the preparation of the financial statement. Dr Martin thanked the auditors for their help in preparing the financial statement.

The report was adopted and Dr Parke moved a vote of thanks to Dr Martin for her work as Treasurer during the past year.

4. **Phycological Bulletin.** The Editor (Dr E. Conway) reported that Council had decided upon the following two points of general policy with regard to future numbers of the Bulletin: (i) that in view of the extensive lists of algal literature now being published in the Bulletin of the American Phycological Society, the practice of including lists of recent literature which was begun in our Bulletin No. 4 would not be continued. Information about good **sources** of up-to-date algal bibliographies, however, e.g., the American Bulletin just mentioned, would be welcome contributions to our Bulletin. An exchange of Bulletins has been arranged by the editors of the American and British Bulletins, and the American publication will be available for reference at meetings of our Society, (iii) that letters from members would be very welcome in future numbers of the Bulletin. This would be a convenient and useful method of circulating items of research news that may not warrant a full paper; or indeed any topics of phycological interest. Minor records requests for research material, or even unsolved problems, will be gladly received and published.

Dr Conway further remarked that the number of libraries now subscribing to the Bulletin is most encouraging. 17 of the home Universities or Colleges have placed regular orders under our library membership scheme and most of these have been anxious to have a full set of the Bulletins. Stocks of the earlier numbers are now quite small and it is hoped that any member who knows of a departmental library that is thinking of acquiring the Bulletin will encourage the placing of an order as soon as possible.

Dr Blackler proposed a vote of thanks to Dr Conway for her work as Editor of the Bulletin during the past year and to Dr Moss for her assistance.

5. **The Programme for the Field Meeting** to be held at **Flatford Mill Field Centre, Essex,** September 11th-18th 1957, was next discussed. The Secretary reported on very helpful correspondence with the Warden, Mr F.J. Bingley, who had agreed to give an introductory talk and had suggested several possible excursion areas. Dr R.W. Butcher outlined some of the algal possibilities of the area, and extended an invitation to the Society to make a one-day excursion from Flatford to the Fisheries Laboratory at Burnham-on-Crouch. Professor Newton thanked Dr Butcher for this kind invitation, which would certainly be included in the programme. The Secretary remarked that details of the meeting would be sent to members in a few months' time. It would then be necessary for members to make firm reservations by June 1st 1957 at latest.

6. **Election of Auditors for 1957.** Dr Martin proposed that Dr G.C. Ainsworth and Professor W.T. Williams be asked to continue serving as Hon. Auditors to the Society; this was agreed and a vote of thanks was accorded to these members for their past services.

7. **Election of Officers and Members of Council for 1957.** The following Officers were now unanimously elected to the 1957 Council: **President:** Dr J.W.G. Lund; **Vice-Presidents:** Dr E.M. Burrows and Dr G.E. Fogg.

Four nominations had been received for three vacant offices of **Ordinary Member.** The result of the postal ballot for these offices was worked out during the course of the meeting by Dr P.S. Dixon and Dr. J.K. Spearing, and the Chairman now announced that Dr K.M. Drew Baker, Miss D. Ballantine and Dr F.E. Round had been elected; these members will serve for the usual period of two years. All other members of Council were re-elected. (A complete list of members of Council for 1957 is given on p.(ii) of this Bulletin).

8. Professor Newton proposed a warm vote of thanks to the Master and Vice-Master of Birkbeck College, and to Professor Ingold and his staff of the Botany Department, for all the facilities and kind hospitality given to the Phycological Society that day; this was heartily carried.

Other business:

1. Dr J.W.G. Lund reported that there was a move afoot to start a new Journal devoted largely to all aspects of freshwater studies although some aspects of marine research might be included. The bias, however, would be freshwater and biological. It was hoped to have 2 or 3 issues, with a total of 250-300 pp. per year; price approx. 30/- to £2 per year. Several members spoke in support of such a journal and after replying to several questions, Dr Lund asked how many of the members present would probably subscribe to it; 10 members thought they would probably take it personally and 17 thought that their institutional libraries would subscribe to it.

2. The Secretary read a letter from Dr G.W. Lawson (University College, Achimota, Gold Coast, West Africa) suggesting that the Society might consider establishing its own library of reprints donated by members, the reprints to be available on loan to members who would pay postage costs. Council had considered this matter and had decided not to undertake such a scheme at the present time. Rather all members who could do so were now asked to send reprints of their papers to isolated academic centres such as Achimota, that have great difficulty in building up good libraries from scratch.

3. The Secretary read a letter from Dr M.B.E. Godward suggesting that the winter meeting be carried on for longer than one day if a sufficient number of members or their students wished to read papers to the Society. This year Dr Godward had several overseas research students who were finishing their studies and would not now have an opportunity to read papers to the Society.

   Council had considered this matter and agreed that it is highly desirable that any member who wished to read a paper at the winter meeting should be enabled to do so. This was the first occasion on which more papers had been available than could be fitted comfortably into one day. In future papers would be invited on the preliminary notice to members and the length of the meeting (up to 1½ or 2 days) would be determined by the number of suitable papers offered. The Secretary asked the 40 members present how many of them could, and would, have attended, say, an extra half-day of papers on the present occasion, and a large majority indicated that they would have stayed. The need for a longer winter meeting is certainly an indication of the increased stature of the Society.

There being no further business, the Chairman thanked members for their attendance and declared the meeting closed.

H.T. POWELL, Hon. Secretary.

During the evening of 3rd January 1957 the Vice-Master of Birkbeck College kindly invited the Officers of the Society to a dinner party at Birkbeck which was attended also by Professor Ingold and some of his staff and at which we had the added pleasure of meeting Dame Helen Gwynne-Vaughan. This further hospitality of Birkbeck College was very much appreciated.

BRITISH PHYCOLOGICAL SOCIETY.

Income and Expenditure Account for year ended November 1, 1956.

Expenditure	£.	s.	d.	Income	£	£.	s.	d.
Printing Bulletin III (250 copies)	46	6	11	Subscriptions received 1956	97			
Printing Bulletin IV (250 copies)	45	6	3	*Less* subscriptions received in arrears 1955	3			
Editor's postages and and stationery	3	13	7	*Less* subscriptions received for 1957	2			
Postages and stationery	17	13	11	*Add* subscriptions in arrears 1956	9	101	0	0
Refund of subscription	1	0	0	Sale of Bulletins		16	0	6
				Sale of Reprints		1	1	9
Surplus.........	6	0	7	Sale of record cards		1	19	0
	120.	1.	3.			120.	1.	3.

Balance Sheet at November 1, 1956

Capital and Liabilities	£.	s.	d.	Assets	£.	s.	d.
Capital at Nov. 3, 1955	160	13	7	Balance at Bank	159	14	2
Subscriptions in advance for 1957	2	0	0	Subscriptions in arrears	9	0	0
	162	13	7				
Add surplus	6	0	7				
	168.	14.	2.		168.	14.	2.

(Signed) M. T. MARTIN,
Hon. Treasurer.

We certify that the above Balance Sheet and Income and Expenditure Account are in accordance with books and vouchers of the British Phycological Society, which we have duly audited, and in our opinion they give a true and correct view of the transactions of the Society for the period November 3rd 1955 to November 1st. 1956 and its position at November 1st, 1956.

W. T. Williams)
(Signed)) Hon. Auditors.
G. C. Ainsworth)

AUTHORS' ABSTRACTS OF PAPERS READ AT BIRKBECK COLLEGE, LONDON, 3rd JANUARY 1957.

1. Some aspects of growth and development in *Gracilaria verrucosa* (Huds.) Papenf.

W.E. Jones.

Related aspects of the vegetative growth and fruiting cycles of *Gracilaria verrucosa* have been studied. In the former the fresh weight of tetrasporophytes and female gametophytes has been measured, the plants being grown on a barge in the Menai Straits. The weight of tetrasporophytes increased steadily from September to the end of November, but a simultaneous decrease occurred in female gametophytes which was due to their more rapid loss of material following decay. From December to April loss and growth in both groups was roughly balanced. Rapid summer growth began at the end of April in tetrasporophytes and a forthight later in female gametophytes: a difference was also shown by newly collected plants placed on the barge at this time. This lag may be due to the female gametophytes having suffered more loss during winter and having greater deficiencies to make good before the new summer growth is measurable.

The growth cycle is related to the annual changes of light and temperature and the fruiting cycle is also correlated with it. Laboratory tests have been made of the readiness of plants to shed viable spores at various seasons. The minimum number of female gametophytes bearing cystocarps on the shore is seen in April and the maximum between November and January. Since plants are greatly reduced in size in winter, however, the maximum production of carpospores should coincide more closely with the maximum size of fruiting plants and probably occurs in August. Tetraspore development begins in February and mature, viable spores may be obtained in late March. Their maximum production appears to occur in June - July and most are shed by September - October, although production continues in the younger branches until November. Male plants are scarce but observations suggest a maximum production of spermatia in June - September and a minimum in December - January.

Very many spores are produced and large numbers may be shed in a short time (e.g., 1600 carpospores from one cystocarp in 90 minutes). They normally begin dividing in 24 - 30 hours after shedding. Immature spores are seldom shed. Division of carpospores within the pericarp does not normally occur. It is suggested that shedding involves the production of mucilage by the mature spores (or the surrounding cells) which causes an increase in pressure as it takes up water, resulting in the exudation of carpospores, tetraspores and perhaps also spermatia. Mucilage frequently accumulates at the carpostome (ostiole of the cystocarp) after carpospore shedding ceases and the initial attachment of tetraspores and carpospores to the substratum appears to be by mucilage.

In the tetrasporophyte the slit opened by the emerging tetraspores closes behind them, leaving little space through which pathogens may enter, compared with that offered by the carpostome. Autumn decay often begins in an empty cystocarp, resulting in the loss of the healthy distal part of the branch. In tetrasporophytes, on the other hand, decay usually works backwards from damaged tips. This largely accounts for the more rapid loss of weight in female gametophytes in the autumn.

2. Studies in the autecology and cytology of *Furcellaria fastigiata* (L.) Lamour.

A.P. Austin.

Furcellaria fastigiata occurs in the sublittoral and lower littoral zones of rock and boulder shores on British and other north Atlantic coasts. It exists in another form -

forma *aegagropila* (Ag.) Reinke - which flourishes in a loose unattached condition in various parts of the Danish Baltic, and is used commercially in the production of agar.

The weed is taken in quantity from an area in the southern Kattegat north of Bønnerupstrand. Harvesting presents no difficulties since the weed mass is pratically pure *F. fastigiata* f. *aegagropila*. These plants are bushy, highly branched clusters, with thin thalli, and no holdfasts. Fertile structures are absent from this form but attached plants, collected not more than a few miles away, bear fruiting ramuli; this precludes reduced salinity as the factor responsible for the characteristics of the unattached form.

It is estimated that plants are removed from this large mass of sterile weed more rapidly than they could be replaced by individuals carried by currents from other areas. Although encouraged by the habitat conditions, it is unlikely that fragmentation alone accounts for more than a part of the increase in individuals. However, the majority of these unattached plants bear numbers of small superficial shoots (called adventitious by Rosenvinge) on their upper dichotomies. These shoots develop in close cluster, in all probability from minute superficial scarring of the apical region caused by movement of the plant clusters over the sandy bottom. They have a restricted plane of attachment on the thallus and are easily detached, always before the shoots reach a length of 6 - 8 mm. Intermediate stages between the largest of the attached shoots and the smallest plants in the weed mass have been distinguished, and these superficial shoots can thus be said to function as propagulae.

Growth of the attached form throughout the year has been investigated by measuring plants, in situ, at fortnightly intervals. Growth rate is maximal between February and June. Annual increase in length in the attached plants (in a lower littoral community) is small, about 2.5 cm. per year, and appears to be independent of the age and size of the shoot up until mature length when fruiting takes place. The stature of the plant varies according to the type of habitat in which it grows but fruiting normally occurs during the 4th to 7th year. It is believed that the unattached form has a greater productivity. Chromosome counts show a large percentage of the f. *aegagropila* plants to be diploid.

In Britain the species exhibits the normal diplobiontic type of life history. Meiosis occurs in the tetrasporangium over a short specific period and can be observed on only a few days early in November. The chromosomes have been demonstrated by modifications of the iron-aceto-carmine schedule which has also yielded chromosome counts in a number of other Florideae.

The phases of meiosis are clear and exhibit little divergence from those shown in the more easily worked material of higher plants; some of these differences can be traced to variations in fixation. At late diplotene or diakinesis the chromosomes can easily be counted; n = 34.

The first part of the diploid nuclear phase - the carposporophyte - has an interesting developmental history. It seams that fertilization occurs in the usual way despite the fact that the actual process has not been observed. It is possible, however, that haploid as well as diploid carpospores can be produced in the absence of fertilization, the diploid condition arising by the fusion of pairs of nuclei in certain cells of the carpogonial branch system.

The primary gonimoblast filaments are produced in number, and often from hypogenous cells, although there is an absence of cell fusions across which a zygotic nucleus or its derivation could migrate.

It is likely that the species, like other red algae, is genetically inefficient and that more than one sequence of events might take place resulting in a certain degree of infertility; monoecious plants can be found but are extremely rare.

3. Iodide and the respiration of *Laminaria digitata*.

T. I. Shaw.

The effect of iodide upon the respiration rate of *Laminaria digitata* fronds has been investigated. A standard Warburg apparatus was used to follow the uptake of oxygen volumetrically while the tissue remained in the dark. The basal respiration rate was followed for a period of two to three hours before a solution of sodium or potassium iodide in sea water was tipped from a side-arm on to the weed and the measurements continued.

A five-fold increase in the respiration rate followed the addition of iodide. This high rate was not maintained but after a period fell suddenly to the pre-treatment rate.

The rate of oxygen consumption in the presence of iodide was so great in relation to the thickness of the frond and the diffusibility of oxygen that it could be shown that this respiration was occurring most rapidly at the surface of the weed. Moreover, since the replacement of air in the manometer by pure oxygen failed to hasten the respiration of iodide treated weed, it was concluded that the localization of metabolic machinery rather than the low diffusibility of oxygen accounted for the site of respiration.

Iodine analyses revealed that the burst of respiratory activity associated with the addition of iodide was accompanied by the disappearance of that element from the sea water - apparently by absorption into the weed.

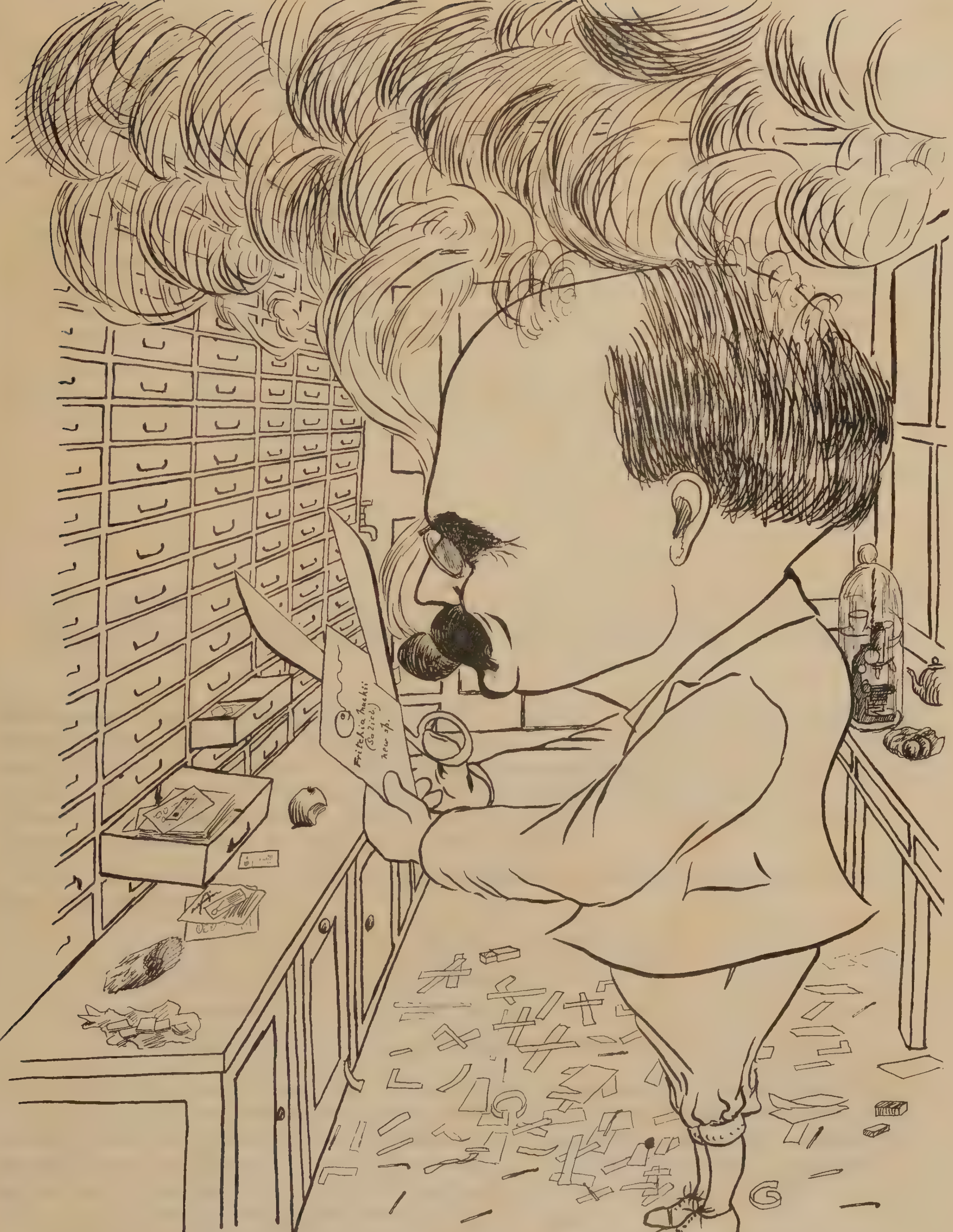
The respiratory quotient of the *Laminaria* was between 0.90 and 1.0 in both iodide treated and untreated sample. The average value of 0.94 suggested that a sugar, possibly mannitol (RQ 0.92), was the substrate for respiration.

The amount of oxygen taken up for each iodide ion added to the weed varied from about 3 to 6 molecules, values close to 3 occurring most frequently. This variation is larger than can be explained by experimental error. In view of the RQ it appears that only one to two iodide ions are taken up for each six carbon sugar units oxidized. This suggests that a very limited number of reactions (only one or two) which occur in the breakdown of carbohydrates are involved in the uptake of iodide.

PROFESSOR F.E. FRITSCH'S COLLECTION OF ILLUSTRATIONS OF FRESHWATER ALGAE

Professor Fritsch was a remarkable man and managed to do so much that one might well imagine that, even in his free time, he worked to a pre-arranged schedule. If he did it was never obvious to me and it was certainly not a rigid one. He was however always doing something and it is not surprising that in his later years at least he often looked tired. However, he rarely let tiredness defeat him, he merely retired, as it were, from more to less active operations. It was at such times, and in odd moments that could not be usefully utilised otherwise, that he compiled his invaluable collection of illustrations of freshwater algae; known to his students as the scrap collection. The delightful caricature by Professor F.M. Haines shows him in 1922 entering a remarkable new species, apparently discovered by Dr, now Sir Edward, Salisbury. By then the collection was about ten years old and its vast size in the picture, far larger than it is to-day, may be ascribed to artistic licence.

This collection is now at the Windermere Laboratory of the Freshwater Biological Association. It contains figures from separates sent to him and as there were many he could



"THE SCRAP COLLECTION"

PROFESSOR F. E. FRITSCH - 1922

Drawn by F. M. Haines

not cut up without destroying parts of the text, there is also a number of sheets with only a heading. The result is reminiscent of a stamp collection, some genera being much better represented than others. By far the most extensive part is that devoted to desmids, which were of especial interest to him, and when dealing with them he also made entries concerning their geographical distribution and sexual reproduction in notebooks which are also in our laboratory. Recently a grant has been obtained for assistance in maintaining, extending and re-housing the collection during the next five years. There is no need to explain to phycologists how useful this collection is; the purpose of this note is to advertise its existence and tell them that the Council of the Freshwater Biological Association hopes it will be often used. It will not be possible to send the sheets out on loan but, in cases of difficulty, it may be possible to send photocopies. It is hoped, however, that most people will be able to come and study the collection at the Ferry House.

My thanks are due to Mrs Fritsch for lending the caricature of Professor Fritsch and to Professor F.M. Haines for allowing it to be reproduced, particularly since it was done so long ago without any thought of it being taken out of its context in this way.

J.W.G. Lund.

LIST OF MARINE ALGAE COLLECTED IN THE DISTRICT AROUND DALE FORT, PEMBROKESHIRE: SEPTEMBER 19th. - 26th. 1956.

Introduction: During the visit of the Phycological Society to the Dale Fort Field Centre from September 19th. - 26th. 1956, collections of the marine algae were made from several of the near-by shores. The Field Centre already holds a considerable number of algal records for the district; but the visit of the Society presented an opportunity of compiling a list of September records, so continuing the general collecting policy of the Society and forming a list which might be useful to other workers at the Centre.

The 179 species here recorded have been identified and the lists for the various classes compiled by the following:

Chlorophyceae	...	E.M. Burrows and P.S. Dixon
Phaeophyceae	...	H. Blackler
Rhodophyceae	...	K.M. Drew Baker
Myxophyceae	...	H.T. Powell and H.G. Powell.

General Description of the Area: The Dale Peninsular consists mainly of cliffs of Old Red Sandstone with Silurian beds to the north at Marloes Bay. The bold headlands are interrupted by sandy bays; and in these many of the large, partially submerged boulders carried large growths of *Porphyra umbilicalis* (f. *umbilicalis* and f. *laciniata*) in September. This area is one of the few remaining sites from which the *Porphyra* is still gathered for sale as *Laver-bread* in the markets of Swansea and Cardiff.

The deep rocky pools on Great Castle Head at the southern end of Westdale Bay and the sloping ledges of St. Bride's Haven offered particularly good collecting areas on Sept. 20th. and 21st., and were in contrast with the mud-flats of the estuaries of the rivers Gann and Cleddau which were visted on September 23rd. and 25th. The prevailing wind for the district is south-westerly and so Marloes Bay Westdale Bay, St. Bride's Haven and St. Ann's Head offered examples of exposed sites and showed the presence of algal species characteristic of exposed coasts as well as the presence of mussel occupying large areas of the inter-tidal rocks.

The tidal range on the outside of the Dale Peninsular is quoted in the Admiralty Tide Tables as approximately 19 feet at Spring tides and 8.6 feet at Neap tides the tidal change of Spring tides coming at mid-day The Society's visit was made at the end of a period of rather poor spring tides and in many cases the lower reaches of the shore were not seen uncovered. But through the much appreciated co-operation of the Warden of the Field Centre. dredging on several days was carried out from the Centre's boat in Dale Roads and adjacent waters; and this added a number of records to the list.

Systematic List: In the main the order of listing and the nomenclature follows the Algal Check-list (Parke, 1953); the inter-tidal zones are delimited in the sense used by Stevenson (1949) Algal records for Skokholm (which the party visited on September 24th) are not included except in the case of the Myxophyceae. In her list of the Marine Algae of Skokholm, Dr Mary Gillham (1954), recorded some 7 species of the blue-greens all of them queried. The present list gives 10 species from Skokholm; all were collected in the supra-littoral fringe on one exposed reef just north of the Head at the south-west part of the island. These records are offered by the collectors to Dr Gillham as an addition to her list and as a slight token of gratitude for her help and co-operation in organising for the Society a memorable excursion.

CHLOROPHYCEAE

Chlorochytrium cohnii Wright. In *Blidingia minima*. Marloes Bay.

Chlorochytrium sp. In mucilage tubes of a colonial diatom. Marloes Bay.

Ulothrix flacca (Dillw.) Thur. On rock. Marloes Bay.

Monostroma sp. In streams. Estuary of River Gann.

Blidingia minima (Näg.) Kylin. On sand-covered rocks. Marloes Bay.

Enteromorpha clathrata (Roth.) Grev. On stones in streams. Marloes Bay. Also loose-lying in the sub-littoral in Dale Roads (dredged).

Enteromorpha compressa (L.) Grev. In pools at Marloes Bay; on mud in the River Cleddau estuary.

Enteromorpha intestinalis (L.) Link On stones in stream in St. Bride's Haven; on mud in the estuary of the River Cleddau.

Enteromorpha linza (L.) J. Ag. In pools in Marloes Bay; on rocks in a stream in St. Bride's Haven.

Enteromorpha ralfsii Harv. On mud in the estuary of the River Cleddau.

Ulva lactuca L. Marloes Bay, St. Bride's Haven; Mill Bay. On mud in the estuary of the River Cleddau.

Chaetomorpha aerea (Dillw.) Kütz. On rocks at Mill Bay.

Chaetomorpha melagonium (Web. et Mohr) Kütz. On stones in a stream in the estuary of the River Gann.

Rhizoclonium sp. In pools. Marloes Bay. St. Bride's Haven.

Bryopsis plumosa (Huds.) Ag. In pools. Marloes Bay and St. Bride's Haven.
(? var. *nuda* Holm. In rock crevises. Mill Bay.)

Ostreobium quekettii Born. et Flah. In shells. Dredged from sub-littoral in Dale Roads.

PHAEOPHYCEAE

Acinetospora crinita (Carm.) Kornmann. Lower mid-littoral zone. In pools on *Corallina officinalis* and *Patella vulgata* with *Giffordia hincksiae;* with plurilocular sporangia. West Marloes Bay.

Ectocarpus confervoides (Roth.) Le Jol. Sub-littoral. Epiphytic on *Laminaria hyperborea;* with plurilocular sporangia. St. Bride's Haven and Thorny Pit.

Ectocarpus crouanii Thur. Upper mid-littoral zone. Epiphytic on *Scytosiphon lomentaria* where it forms small tufts; with plurilocular sporangia. Thorny Pit.

Ectocarpus draparnaldioides (Crn.) Kjellm. Sub-littoral. Growing on *Laminaria hyperborea* and *Saccorhiza polyschides* with *Giffordia hincksiae;* with plurilocular sporangia. St. Bride's Haven, Great Castle Bay, Thorny Pit.

Ectocarpus fasciculatus Harv. In deep pools, lower mid-littoral zone and in sub-littoral fringe. Common. Growing on *Laminaria digitata, Saccorhiza polyschides, Alaria esculenta* and *Rhodymenia palmata.*

. Very small plants and early stages of development found on immature sporophylls of *Alaria.* Small plants on *Laminaria digitata* in pools. All with plurilocular sporangia. St. Bride's Haven, Great Castle Bay and Thorny Pit.

Giffordia granulosa (Sm.) Hamel. Upper mid-littoral zone. In shallow Coralline pools on high exposed rocks. Unilocular and plurilocular sporangia on the same plants. West Marloes Bay and Thorny Pit.

Giffordia hincksiae (Harv.) Hamel. Sub-littoral fringe to sub-littoral zone. Epiphytic on *Laminaria hyperborea* and *Saccorhiza polyschides;* with unilocular and plurilocular sporangia. St. Bride's Haven, Great Castle Bay.

Hecatonema maculans (Coll.) Sauv. Mid-lattoral zone on *Polysiphonia nigrescens* and *Corallina officinalis;* with plurilocular sporangia. West Marloes Bay.

Herponema velutinum (Grev.) J. Ag. In lower mid-littoral zone and sub-littoral fringe. Growing on *Himanthalia elongata* abundantly; with unilocular sporangia. St. Bride's Haven and Great Castle Bay.

Pylaiella littoralis (L.) Kjellm. Upper to lower mid-littoral zone. Epiphytic on *Fucus spiralis, Ascophyllum nodosum, Fucus vesiculosus* and *Fucus serratus.* Very common on *Ascophyllum nodosum;* with unilocular and plurilocular sporangia. Westdale Bay, West Marloes Bay, St. Bride's Haven, Thorny Pit, Great Castle Bay, Gann Estuary, River Cleddau at Llangwm, Neyland Slipway.

Spongonema tomentosum (Huds.) Kütz. Mid-littoral zone. On *Fucus vesiculosus;* with plurilocular sporangia. Westdale Bay.

Streblonema parasiticum (Sauv.) de Toni. Lower mid-littoral zone. Parasitic in *Cystoclonium purpureum,* abundant in the stipe and branches. St. Bride's Haven.

Waerniella lucifuga (Kuck.) Kylin. Supra-littoral to supra-littoral fringe. In cracks and crevices of rock and in caves, on shaded damp rock faces; with plurilocular sporangia. Abundant in places. West Marloes Bay, West of Chapel Bay near Angle and Llangwm.

Ralfsia verrucosa Aresch., J. Ag. Upper mid-littoral zone. On rock and in cracks and crevices and on *Patella vulgata.* Not common. West Marloes Bay, St. Bride's Haven.

Elachista fucicola (Velley) Aresch. f. *fucicola.* Upper to lower mid-littoral zone. Common. Epiphytic on *Fucus spiralis, Fucus vesiculosus, Fucus serratus* and *Ascophyllum nodosum;* with unilocular sporangia. West Marloes, St. Bride's Haven, Thorny Pit, Gann Estuary, River Cleddau at Llangwm and Neyland Slipway.

Elachista scutulata (Sm.) Duby. Lower mid-littoral zone to sub-littoral fringe. Occasional. On receptacles of *Himanthalia elongata;* with unilocular sporangia. St. Bride's Haven.

Cylindrocarpus berkeleyi (Grev.) Crn. In upper mid-littoral zone. In cracks and crevices of rock and on *Ralfsia verrucosa,* not common; with unilocular sporangia. West Marloes Bay, St. Bride's Haven, Thorny Pit.

Leathesia difformis (L.) Aresch. In lower mid-littoral zone. Growing on rocks with *Laurencia pinnatifida;* old worn plants and small young ones present. St. Bride's Haven and Thorny Pit.

Litosiphon pusillus (Carm.) Harv. In sub-littoral zone. Dredged in Dale Bay. Epiphytic on *Chorda filum.*

Dictyosiphon chordaria Aresch. Upper mid-littoral zone. Growing on rock in a pool; with unilocular sporangia. St. Bride's Haven.

Colpomenia peregrina Sauv. In mid-littoral zone. Small sterile plants in rock pools. St. Bride's Haven.

Petalonia fascia (Müll.) Kuntze. In sub-littoral. On keel of rowing boat and on buoy in Dale Harbour.

Scytosiphon lomentaria (Lyngb.) Endl. var. *lomentaria.* In upper mid-littoral zone. Small sterile plants in rock pools. Occasional. St. Bride's Haven, Thorny Pit, Gann Estuary.

Aglaozonia parvula (Grev.) Zanard. Sub-littoral. Dredged off Skokholm occurring on pieces of stone.

Desmarestia aculeata (L.) Lamour. Cast up. St. Bride's Haven.

Desmarestia ligulata (Lightf.) Lamour. Cast up. St. Bride's Haven.

Chorda filum (L.) Stackh. Lower mid-littoral to sub-littoral zone. Small plants growing in mud and on stones in Gann Estuary. Rare. Long plants cast up Thorny Pit and dredged in Dale Bay.

Laminaria digitata (Huds.) Lamour. Lower mid-littoral to sub-littoral fringe. In deep pools in lower mid-littoral and on rocks at lower levels. Common. West Marloes Bay, St. Bride's Haven, Thorny Pit, Great Castle Bay.

Laminaria hyperborea (Gunn.) Fosl. Sub-littoral fringe to sub-littoral, on rocks. West Marloes Bay, St. Bride's Haven, Thorny Pit.

Laminaria saccharina (L.) Lamour. In sub-littoral fringe to sub-littoral. In pools and on rocks. Great Castle Bay, Thorny Pit, cast up in St. Bride's Haven, dredged in Dale Bay. Growing on *Saccorhiza polyschides* on buoy in Dale Harbour.

Saccorhiza polyschides (Lightf.) Batt. Sub-Littoral fringe to sub-littoral zone. Growing on exposed rocks Great Castle Bay and on buoy in Dale Harbour (278 cm. long on buoy). Cast up St. Bride's Haven and dredged in Dale Harbour. Unilocular sporangia on plants from Great Castle Bay.

Alaria esculenta (L.) Grev. Sub-littoral fringe to sub-littoral. Growing on exposed rocks. Great Castle Bay, St. Bride's Haven.

Sphacelaria fusca (Huds.) Ag. Upper to lower mid-littoral zone. Common. On rocks and in pools on *Corallina officinalis*. Propagules abundant, West Marloes Bay, St. Bride's Haven, Thorny Pit and Neyland slipway.

Halopteris filicina (Grat.) Kütz. var. *filicina*. Sub-littoral. Dredged in Dale Bay.

Cladostephus spongiosus (Huds.) Ag. Mid-littoral to sub-littoral. Not common. On rocks West Marloes Bay, Thorny Pit and Neyland Slipway. Dredged in Dale Bay.

Cladostephus verticillatus (Lightf.) Ag. Sub-littoral. Dredged in Dale Bay.

Dictyopteris membranacea (Stackh.) Batt. Sub-littoral. Dredged off Skokholm.

Dictyota dichotoma (Huds.) Lamour. var. *dichotoma*. Mid-lattoral. On rocks and in pools; with tetraspores. Westdale Bay, West Marloes Bay, Great Castle Bay and Thorny Pit.

Dictyota dichotoma (Huds.) Lamour. var. *intricata* (Ag.) Grev. Mid-littoral zone. Not common. On rocks. Thorny Pit.

Ascophyllum nodosum (L.) Le Jol. f. *nodosum*. Mid-littoral. With *Fucus spiralis* and *Fucus vesiculosus*. Very abundant in sheltered positions, on rocks and boulders. Westdale Bay, West Marloes Bay, St. Bride's Haven, Thorny Pit, Great Castle Bay, Dale below the Fort, Gann Estuary, River Cleddau near Hook and Llangwm (very abundant at latter place), Neyland Slipway. With *Polysiphonia lanosa* on it except in upper part of estuary at Llangwm.

Fucus ceranoides L. Upper to mid-littoral zone. On small stones in mud. Gann Estuary; abundant in River Cleddau at Llangwm.

Fucus serratus L. Lower mid-littoral zone. On rocks and stones. Fertile. Westdale Bay, West Marloes Bay, St. Bride's Haven. Great Castle Bay, Thorny Pit, Dale below Fort, Gann Estuary, River Cleddau near Hook, Llangwm and Neyland Slipway.

Fucus spiralis L. Upper mid-littoral. Fertile. On rocks and stones. Westdale Bay, West Marloes Bay, Great Castle Bay, St. Bride's Haven. Thorny Pit, Dale below Fort, Gann Estuary, River Cleddau near Hook, Llangwm and Neyland Slipway.

Fucus vesiculosus L. Mid-littoral. On rocks. Westdale Bay, West Marloes Bay, Great Castle Bay, St. Bride's Haven, Thorny Pit, Dale Fort, Gann estuary, River Cleddau near Hook, Llangwm and Neyland Slipway.

Fucus vesiculosus L. var. *evesiculosus* Cotton. Upper Littoral zone. On top of very high exposed rocks. Thorny Pit.

Pelvetia canaliculata (L.) Decne et Thur. From supra-littoral finge to upper mid-littoral zone. Common on rocks where not too exposed. Fertile. Westdale Bay, West Marloes Bay, St. Bride's Haven, near Angle, Thorny Pit, Great Castle Bay, Dale below Fort, Gann Estuary, River Cleddau near Hook, Llangwm and Neyland Slipway.

Himanthalia elongata (L.) S.F. Gray. Lower mid-littoral zone to sub-littoral fringe. Common. On rocks exposed to wave action. Longer, narrower plants in sub-littoral fringe than in lower mid-littoral zone. Fertile. Westdale Bay, Great Castle Bay and St. Bride's Haven.

Bifurcaria rotunda (Huds.) Papenf. Lower mid-littoral zone. Rare. In pools. Fertile. St. Bride's Haven.

Halidry siliquosa (L.) Lyngb. Mid-littoral zone. In pools. Small young plants seen. St. Bride's Haven.

RHODOPHYCEAE

(This list is not complete, especially as regards the coralline algae.)

Erythrotrichia ceramicola (Lyngb.) Aresch. Upper mid-littoral to sub-littoral region. On *Corallina officinalis*, *Ceramium flabelligerum* and *Callithamnion hookeri*; with monosporangia. Marloes Bay, St. Bride's Haven, Thorny Pit, dredged Dale Roads.

Erythrotrichia welwitschii (Rupr.) Batt. On limpet shells. St. Bride's Haven.

Erythrotrichia sp. This is possibly *E. boryana* (Mont.) Berth but so little material is available and the thalli are so small that identification is unreliable. On *Rhodymenia palmata*. Marloes Bay.

Stylonema alsidii (Zan.) Drew. Upper mid-littoral. On various hosts; with monospores. Collection from Neyland of immature thalli. Neyland headland near Thorn Island and Angle.

Bangia fuscopurpurea (Dillw.) Lyngb. Supra-littoral. Llangwm.

Porphyra umbilicalis (L.) Kütz. From upper to middle mid-littoral. On rocks and *Fucus* sp.; spermatangia and spores formed in 'packets'. Westdale Bay, Marloes Bay, Thorny Pit and St. Bride's Haven.

Porphyra laciniata (Lightf.) J. Ag. Middle mid-littoral and occasionally higher. Cast and attached to rocks and rarely to *Fucus* sp. and *Gigartina stellata*; with spermatangia and spores formed in 'packets'. Marloes Bay, Great Castle Bay, Thorny Pit, Llangwm, Neyland, Gann Estuary and headland near Thorn Island and Angle.

Porphyra sp., On *Fucus* sp.; with spermatangia. Thorny Pit.

Conchocelis - phase of either *Porphyra* or *Bangia*. In cast shells; dredged Dale Roads and Great Castle Bay.

Rhodochorton floridulum (Dillw.) Naeg. Middle mid-littoral. Few tetrasporangia at Westdale. Westdale Bay, Marloes Bay, St. Bride's Haven, Thorny Pit and Great Castle Bay.

Rhodochorton purpureum (Lightf.) Rosenvinge. Supra-littoral. Llangwm.

Rhodochorton rothii (Turt.) Naeg. Upper and middle mid-littoral. Marloes Bay, St. Bride's Haven, Thorny Pit, Llangwm and headland near Thorn Island and Angle.

Rhodochorton secundatum (Lyngb.) comb. nov. On *Rhodymenia palmata*; with monosporangia. Marloes Bay, St. Bride's Haven and Thorny Pit.

This species is here included in the genus *Rhodochorton* as emended by Drew (1928) and hence the new combination is necessary. For synonyms see Papenfuss (1945, p. 323).

Nemalion multifidum (Web. et Mohr.) J. Ag. St. Ann's Head and St. Bride's Haven.

Gelidium crinale (Turn.) Kütz. Tetrasporangia. Marloes Bay, Westdale Bay and St. Bride's Haven.

Gelidium latifolium (Grev.) Born. et Thur. Tetrasporangia and spermatangia. Westdale Bay, Marloes Bay, St. Bride's Haven and Thorny Pit.

Pterocladia pinnata (Huds.) Papenf. Westdale Bay.

Cruoria sp. Dredged between Skomer and Skokholm.

Furcellaria fastigiata (L.) Lamour. Westdale Bay, St. Bride's Haven, dredged Dale Roads.

Catenella repens (Lightf.) Batt. Mid-littoral. Tetrasporangia. Westdale Bay, Marloes Bay, Great Castle Bay, Thorny Pit and Llangwm.

Calliblepharis ciliata (Huds.) Kütz. Pools. Carposporophytes. St. Bride's Haven, Great Castle Bay, dredged Dale Roads, dredged between Skomer and Skokholm.

Calliblepharis lanceolata (Stackh.) Batt. Westdale Bay and St. Bride's Haven.

Cystoclonium purpureum (Huds.) Batt. Mid-littoral. Attached and cast; with tetrasporangia and carposporophytes. St. Bride's Haven Thorny Pit, dredged Dale Roads, Dale, near Griffin Inn.

Rhodophyllis divaricata (Stackh.) Papenf. Mid-littoral and sub-littoral region. Neyland and dredged Dale Roads.

Plocamium coccineum (Huds.) Lyngb. Mid-littoral and cast; with tetrasporangia and carposporophytes. Marloes Bay, St. Bride's Haven, Thorny Pit, dredged Dale Roads.
f. uncinatum (Ag.) Levring. Marloes Bay.

Gracilaria verrucosa (Huds.) Papenf. Middle and lower mid-littoral, in pools; with tetrasporangia and carposporophytes. Marloes Bay, St. Bride's Haven, Great Castle Bay, dredged Dale Roads.

Ahnfeltia plicata (Huds.) Fries. Westdale Bay, Marloes Bay and Thorny Pit.

Petroglossum nicaeense (Duby) Schotter. Mid-littoral. Thorny Pit. Coll. E.M.F. Swale and identified by K.M. Drew Baker by comparison with material from the Mediterranean.

Phyllophora brodiaei (Turn.) J. Ag. Sub-littoral region; dredged Dale Roads.

Phyllophora membranifolia (Good. et Woodw.) J. Ag. Sub-littoral region; dredged Dale Roads.

Phyllophora rubens (L.) Grev. Sub-littoral region; dredged Dale Roads and dredged between Skomer and Skokholm.

Stenogramme interrupta (Ag.) Mont. Sub-littoral region; dredged Dale Roads.

Chondrus crispus (L.) Stackh. In pools; with tetrasporangia and carposporophytes. Westdale Bay, Marloes Bay, St. Bride's Haven, Great Castle Bay, Thorny Pit and Neyland.

Gigartina stellata (Stackh.) Batt. Cast and attached to rock in lower mid-littoral; dominant on low rocky outcrops. Carposporophytes. Westdale Marloes Bay, St. Bride's Haven, Great Castle Bay, Thorny Pit and Neyland.

Dilsea carnosa (Schmidel) Kuntze. Sub-littoral region; dredged Dale Roads and dredged between Skomer and Skokholm.

Polyides rotundus (Huds.) Grev. Sandy and rocky pools; with young female nemathecia. Westdale Bay, Marloes Bay, St. Bride's Haven and Thorny Pit.

Hildenbrandia prototypus Nardo. Boulders and pebbles in mid-littoral; with tetrasporangia. St. Bride's Haven, Llangwm, Neyland and Gann Estuary.

Corallina officinalis L. Rocks and pools through mid-littoral and sub-littoral region; with tetrasporangia. Westdale Bay, Marloes Bay, St. Bride's Haven, Great Castle Bay, Thorny Pit, dredged Dale Roads.

Epilithon membranaceum (Esper) Heydr. On *Gigartina stellata*. Conceptacles but contents not determined. Westdale Bay.

Lithophyllum incrustans Phil. Conceptacles but contents not determined. Westdale Bay, Marloes Bay and Thorny Pit.

Lithothamnion lenormandii (Aresch.) Fosl. Conceptacles but contents not determined. Marloes Bay and St. Bride's Haven.

Melobasia minitula Fosl. Epiphytic in mid-littoral and sub-littoral region. On *Dictyota dichotoma* and *Cystoclonium purpureum*; with tetrasporangia and carposporophytes. St. Bride's Haven, Thorny Pit, dredged Dale Roads.

Mesophyllum lichenoides (Ellis) Lemoine. Mid-littoral. Conceptacles but contents undertermined. Westdale Bay.

Callocolax neglectus Schm. Mid-littoral and sub-littoral region. Parasitic on *Callophyllis laciniata*. St. Bride's Haven, dredged Dale Roads.

Callophyllis laciniata (Huds.) Kütz. Mid-littoral and sub-littoral region also cast up. Carposporophytes. St. Bride's Haven Thorny Pit. dredged Dale Roads dredged between Skomer and Skokholm.

Kallymenia reniformis (Turn.) J. Ag. Attached in mid-littoral St. Bride's Haven, sub-littoral region elsewhere; with tetrasporangia and carposporophytes. Dredged Dale Roads. St. Bride's Haven. dredged between Skomer and Skokholm.

Holmsella packyderma (Reinsch) Sturch. Mid-littoral and sub-littoral region on *Gracilaria verrucosa*. Great Castle Bay, dredged Dale Roads

Gastroclonium ovatum (Huds.) Papenf. Mid-littoral; with tetrasporangia. Westdale Bay and St. Bride's Haven.

Lomentaria articulata (Huds.) Lyngb. Rock and epiphytic on *Fucus* and *Cladophora* in mid-littoral region; with tetrasporangia and carposporophytes. Westdale Bay, Marloes Bay, St. Bride's Haven. Great Castle Bay and Thorny Pit.

Lomentaria clavellosa (Turn.) Gaill. Mid-littoral; one very small plant. Marloes Bay.

Rhodymenia palmata (L.) Grev. Mid-littoral (attached and cast) and sub-littoral region. Marloes Bay, St. Bride's Haven, Great Castle Bay, Thorny Pit, Neyland, dredged Dale Roads, dredged between Skomer and Skokholm.

Antithamnion sarniense (Lyle) G. Feldm. Sub-littoral region, dredged between Skomer and Skokholm.

Callithamnion hookeri (Dillw.) Ag. Epiphytic in mid-littoral and sub-littoral region. On *Ceramium rubrum*, *Catenella repens* and *Plumaria elegans*, with tetrasporangia. Westdale Bay, St. Bride's Haven, Thorny Pit, dredged Dale Roads.

Callithamnion tetragonum (Wither.) Ag. Mid-littoral; with tetrasporangia. Marloes Bay and Thorny Pit.

Callithamnion tetricum Ag. Mid-littoral, some epiphytic on *Laurencia pinnatifida*; with tetrasporangia and carposporophytes. Marloes Bay and St. Bride's Haven.

Ceramium acanthonotum Carm. ex Harv. Mid-littoral. on rock and mussel shells; with tetrasporangia, Marloes Bay, St. Bride's Haven and Thorny Pit.

Ceramium ciliatum (Ellis) Ducluz. Mid-littoral pools. St. Bride's Haven and Great Castle Bay.

Ceramium deslongchampsii Chauv. Mid-littoral. Neyland.

Ceramium echionotum J. Ag. v. *transcurrens* (Kütz.) Batt. With tetrasporangia. St. Bride's Haven.

Ceramium flabelligerum J. Ag. Mid-littoral; on mussels; with tetrasporangia, Westdale Bay, Marloes Bay, St. Bride's Haven and Thorny Pit.

Ceramium rubrum (Huds.) Ag. Rock and epiphytic in mid-littoral; with spermatangia, tetrasporangia and carposporophytes. Westdale Bay Marloes Bay, St. Bride's Haven, Great Castle Bay and Thorny Pit.

Ceramium strictum Harv. Mid-littoral. Llangwm.

Griffithsia flosculosa (Ellis) Batt. Pools, mid-littoral; with tetrasporangia and carposporophytes. Westdale Bay. Marloes Bay. St Bride's Haven, Great Castle Bay and Thorny Pit.

Halurus equisetifolius (Ag.) Kütz. Mid-littoral and one very young plant in the sub-littoral region attached to shell. Thorny Pit dredged between Skomer and Skokholm.

Plumaria elegans (Bonnem.) Schm. Mid-littoral; with parasporangia. Westdale Bay, St. Bride's Haven and Great Castle Bay.

Spermothamnion repens (Dillw.) Rosenv. Mid-littoral; epiphytic on *Ceramium rubrum*. Westdale Bay.

Spyridia filamentosa (Wulf.) Harv. Sub-littoral region; with tetrasporangia. Dredged Dale Roads.

Acrosorium uncinatum (J. Ag.) Kylin. Mid-littoral and sub-littoral region. Marloes Bay, Thorny Pit, dredged between Skomer and Skokholm.

Acrosorium reptans (Crn.) Kylin. Sub-littoral region; dredged Dale Roads.

Cryptopleura ramosa (Huds.) Kylin. Mid-littoral including pools and sub-littoral region; some epiphytic on *Corallina officinalis*; with tetrasporangia and carposporophytes. Westdale Bay, Marloes Bay, St. Bride's Haven, dredged Dale Roads, dredged between Skomer and Skokholm.

Cryptopleura ramosa (Huds.) Kylin *v. uncinata* Grev. Sub-littoral region; dredged Dale Roads.

Delesseria sanguinea (Huds.) Lamour. Mid-littoral and sub-littoral region. Marloes Bay, dredged Dale Roads.

Hypoglossum woodwardii Kütz. Mid-littoral and sub-littoral region; with tetrasporangia. Marloes Bay, Thorny Pit, dredged Dale Roads.

Membranoptera alata (Huds.) Stackh. Mid-littoral; also cast. Westdale Bay, St. Bride's Haven, Thorny Pit, dredged Dale Roads.

Nitophyllum punctatum (Stackh.) Grev. Sub-littoral region, dredged between Skomer and Skokholm.

Phycodrys rubens (Huds.) Batt. Mid-littoral and sub-littoral region and cast. St. Bride's Haven, Thorny Pit, dredged Dale Roads.

Heterosiphonia plumosa (Ellis) Batt. Attached at Westdale but otherwise cast; with tetrasporangia and carposporophytes. Westdale Bay, St. Bride's Haven, dredged Dale Roads, dredged between Skomer and Skokholm.

Bostrychia scorpioides (Huds.) Mont. Supra-littoral. Llangwm and Gann Estuary.

Laurencia hybrida (D.C.) Lenorm. Upper mid-littoral pools. St. Bride's Haven, Thorny Pit and Neyland.

Laurencia pinnatifida (Huds.) Lamour. Mid-littoral; with tetrasporangia. Westdale Bay, Marloes Bay, St. Bride's Haven, Thorny Pit and Neyland.

Polysiphonia brodiaei (Dillw.) Grev. Mid-littoral; with spermatangia, carpogonia and carposporophytes. Marloes Bay and St. Bride's Haven.

Polysiphonia elongata (Huds.) Harv. Sub-littoral region; dredged between Skomer and Skokholm.

Polysiphonia fibrata (Dillw.) Harv. Mid-littoral; with tetrasporangia and carposporophytes. St. Bride's Haven and Thorny Pit.

Polysiphonia lanosa (L.) Tandy. Mid-littoral. Epiphytic on *Ascophyllum nodosum* and *Fucus serratus*; with tetrasporangia. St. Bride's Haven, Thorny Pit and Llangwm.

Polysiphonia nigra (Huds.) Batt. Marloes Bay.

Polysiphonia nigrescens (Sm.) Grev. Mid-littoral; with spermatangia and tetrasporangia. Westdale Bay, Marloes Bay, and St. Bride's Haven.

Polysiphonia opaca (Ag.) Zanard. Upper mid-littoral; in deep crevices. Coll. P.S. Dixon; with tetrasporangia. Marloes Bay.

Polysiphonia urceolata (Dillw.) Grev. Mid-littoral. Thorny Pit.

Rhodomela confervoides (Huds.) Silva. Mid-littoral and sub-littoral region; with tetrasporangia. Thorny Pit, dredged Dale Roads.

MYXOPHYCEAE
(Papenfuss, 1955)

(Marine species only; species found in estuaries are not included in this list).

Coccochloris elabens (Bréb.) Dr. et Daily Headland opposite Thorn Island, near Angle: frequent among *Chrysotila sp.* in a cave about 3 ft. above top of *Pelvetia* belt.

* *Chlorogloea tuberculosa* (Hansg.) Wille Skokholm: frequent on *Bangia fuscopurpurea* and occasional on filamentous blue-green algae among uppermost *Chthamalus stellatus* and upwards for about 2 ft. vertically.

* *Dermocarpa hemisphaerica* Setch. et Gardn. Westdale Bay: occasional on *Catenella repens* in lower part of supra-littoral fringe zone.

* *Dermocarpa prasina* (Reinsch) Born. et Thur. Mill Bay: on *Aglaothamnion polyspermum* in pools. With endosporangia.

* *Dermocarpa violacea* Crouan. Skokholm: occasional on *Porphyra umbilicalis* and *Blidingia minima* in lower half of supra-littoral fringe zone.

* *Entophysalis granulosa* Kütz. Skokholm: frequent on rock in lower part of the supra-littoral fringe zone.

* *Pleurocapsa amethystea* Rosenv. Skokholm: frequent near top of the supra-littoral fringe zone, occasional in the lower part of this zone: on rock and epiphytic on *Plectonema battersii*.

* *Pleurocapsa crepidinum* Collins. Skokholm: frequent in middle part, occasional in upper part, of supra-littoral fringe zone; on rock.

* *Pleurocapsa fuliginosa* Hauck. Marloes Bay: occasional on rock beside a small pool about 2 ft. above top of *Pelvetia* belt. Skokholm: occasional on rock in middle part of supra-littoral fringe zone.

* *Pleurocapsa kerneri* (Hansg.) Dr. Skokholm: occasional in middle and upper parts of supra-littoral fringe zone, usually on rock but also occasionally epiphytic on *Bangia fuscopurpurea*.

* *Xenococcus gilkeyae* Setch. et Gardn. ex Gardn. Westdale Bay: occasional on *Hildenbrandia sp.* in a cave about 1 ft. above top of *Pelvetia* belt.

Calothrix confervicola Ag. ex B. et F. St. Bride's Haven: frequent on *Cladophora rupestris* and *Enteromorpha sp.* from pools in *Pelvetia* belt; also on free-floating *Polysiphonia nigra*.

Calothrix scopulorum (Web. et Mohr) Ag. ex B. et F. Skokholm: frequent in the middle part of the supra-littoral fringe zone on one exposed reef.

Rivularia atra Roth ex B. et F. St. Ann's Head: frequent in pools at *Pelvetia* level.

Rivularia nitida Ag. ex B. et F. Marloes Bay: frequent in crevices in supra-littoral fringe zone on rock "islands" in the bay.

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* According to Drouet & Daily (1956) all of the ten taxa marked with an asterisk above are to be included in the genus *Entophysalis* Kütz. emend. Dr. et Daily. We agree that many and probably all of the taxa in question are probably merely forms or stages in development of a small number of species, perhaps of a single genus, but we cannot agree that Drouet & Daily's subsequent division of their amended genus *Entophysalis* into species is entirely valid. For example, Drouet & Daily (1956, p. 102) separate all the non-endophytic marine forms into two species - *E. deusta* (on rocks, wood and shells) and *E. conferta* (on larger algae and living animals). However, the specimens identified as *Pleurocapsa amethystea* and *P. kerneri* above were found both on rock and as epiphytes on other algae. *Entophysalis deusta* and *E. conferta* of Drouet & Daily do not appear to be separable by any characteristic other than that of substratum, so if the relevant synonymy given by Drouet & Daily is valid, these two taxa would have to be combined under the earlier name *E. deusta*. This question is being investigated further and we have thought it best, meantime, to list the forms as above.

H.T.P. & H.G.P.

Plectonema battersii Gom. Marloes Bay: frequent on *Mytilus edulis* in mid-littoral zone. Westdale Bay: frequent in cave about 1 ft. above top of *Pelvetia* belt. Skokholm: abundant throughout supra-littoral fringe zone.

Lyngbya aestuarii Liebm. ex Gom. Marloes Bay: frequent beside a small pool about 2 ft. above top of *Pelvetia* belt.

Lyngbya lutea Gom. ex Gom. Marloes Bay: abundant on *Gelidium sp.* from a pool in upper part of mid-littoral zone.

Lyngbya majuscula Harv. ex Gom. Marloes Bay: abundant on *Gelidium sp.* from a pool in upper part of mid-littoral zone. St Bride's Haven: occasional on free-floating *Polysiphonia nigra*.

Lyngbya rivulariarum Gom. Headland opposite Thorn Island, near Angle: frequent among *Chrysotila sp.* in a cave about 3 ft. above top of *Pelvetia* belt.

Microcoleus tenerrimus Gom. Marloes Bay: abundant beside a small pool about 2 ft. above top of *Pelvetia* belt.

Oscillatoria limosa Ag. ex Gom. Marloes Bay: frequent on *Balanus balanoides* at about M.T.L.

Oscillatoria tenuis Ag. ex Gom. Marloes Bay: frequent on *Balanus balanoides* and *Mytilus edulis* at about M.T.L., and beside a small pool about 2 ft. above top of *Pelvetia* belt. Headland opposite Thorn Island, near Angle: abundant on a patch of *Rhodochorton rothii* in upper part of mid-littoral zone.

Phormidium corium Gom. (var. *constrictum* Playfair?) Headland opposite Thorn Island near Angle: frequent on a patch of *Rhodochorton rothii* in upper part of mid-littoral zone.

Phormidium fragile Gom. Westdale Bay: occasional in a cave about 1 ft. above top of *Pelvetia* belt. St Ann's Head: frequent on *Rivularia atra* in pools at *Pelvetia* level. Skokholm: frequent in middle part of supra-littoral fringe zone.

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THE MARINE FLORA OF THE BRITISH ISLES

For the interest of members, the following descriptions of two selected genera, together with one species of each, have been prepared on the lines it is intended to follow in the preparation of the new British marine flora. This flora is being sponsored by the British Phycological Society and it is hoped that members will be encouraged to volunteer to help in its preparation even if they can undertake only one or two species. Since our knowledge of the marine algal vegetation of northern Europe dates from a time when details of structure and reproduction were but very imperfectly known, there are many taxonomic and nomenclatural problems which must be elucidated if this work is to be of lasting scientific value. To achieve this in a reasonable time it will be necessary to have as much assistance as possible.

Those who have already offered to prepare a genus or species may have received schedules on which to collect the information, and a revised version of these is published below; this procedure still holds, but the information so collected will be edited and published along the lines of the examples which follow. In order to save space in the flora, bibliographical references will be cited as in these examples, with full references at the end. Legends for figures have been included in these examples to indicate the type and extent of the proposed illustrations, namely, one set for a single species of each genus. In the case of some genera, a second set of figures illustrating the same feature in all the species may prove to be necessary.

Offers of help should be sent to Dr E. Burrows, Department of Botany, The University of Liverpool, Liverpool 3.

E. Burrows
K.M. Drew
M.T. Martin

REVISED SCHEDULE FOR THE DESCRIPTION OF A GENUS FOR THE FLORA.

1. Name of genus: (with authority and date):
2. Reference to original description:
3. Synonyms:
4. Type species-
   Type locality:
   Location of type specimen:
5. Description of genus:
6. Distribution-
   British Isles:
   World:
7. Reference to monograph or any major work:
8. Key to species of British Isles:

REVISED SCHEDULE FOR THE DESCRIPTION OF A SPECIES FOR THE FLORA.

1. Binomial (without date):
2. Reference to original description, and, if emended, to emended description:
3. Reference to any major work on the species and to a good illustration of the whole plant, its structure and reproduction:
4. Location of type specimen and designation of status:
5. Type locality;
6. Abbreviated synonymy:
7. Description in telegraphic style:

8. Occurrence of reproductive organs, recorded by the month:
9. Distribution in British Isles by County with further information where necessary:
10. Distribution along other European shores as well as those of North America and other countries bordering the North Atlantic Ocean;
11. Habitat:
12. Level on shore with indication of range (the regions to be recognised as follows):
    1. Supra-littoral fringe:
    2. Mid-littoral region, upper and lower:
    3. Sub-littoral fringe:
    4. Sub-littoral region:
    5. Pools:
13. Form and distribution in relation to environmental factors:
    (This includes season, latitude, level on shore)
14. Special notes: (e.g. occurrence of fungi, galls etc.)

Where no information is available this should be stated.

POLYIDES

C. Agardh 1822

Agardh, C., 1822, p. 390.
Spongiocarpus Greville, 1824.
Type species: *Polyides lumbricalis* Ag. *nom. illeg.* =*Fucus rotundus* Huds.
Type locality: St. Ives, Cornwall.
Location of type specimen: Oxford (Herb. Sherard, Europe, no. 1906) Type.

Species marine; thallus perennial, consisting of erect branched axes arising from a basal disc; erect branches solid, dichotomously branched, of multiaxial construction and differentiated into medulla and cortex; cells of cortex with chromatophores.

Tetrasporangia borne laterally in branch-systems forming the cortex, in which they are embedded, cruciately divided.

Sexual organs borne on filaments of nemathecia; nutritive auxiliary cells intercalary in nemathecial filaments, indistinguishable before fusion with gonimoblast.

Carposporophyte of diffuse type, embedded in nemathecium; gonimoblast branched, bearing several gonimolobes, most of which develop near auxiliary cells.

Distribution as for *Polyides rotundus*.

The genus contains a single species.

POLYIDES ROTUNDUS

(Huds.) Grev.

Hudson, W., 1762, p. 471.
Type locality: St. Ives, Cornwall.
Location of type specimen: Oxford (Herb. Sherard, Europe, no. 1906) Type.
Fucus rotundus Huds., 1762, p. 471.
Polyides lumbricalis Ag., 1822, p. 392.

Thallus perennial, saxicolous, several erect branched axes arising from a basal disc, dioecious; disc either small or extensive, up to 2 cm. in diam. consisting of irregularly stratified layers of elongated, thick-walled cells full of floridean starch; erect axes reddish purple terete, dichotomously branched, up to 15 cm. in length, 3 mm. in diam., of multiaxial construction with differentiation into medulla and cortex; medulla consisting of intertwined, elongated, unpigmented cells; cortex of radiating branch-systems, the inner cells of which are large and contain several small discoid chromatophores and the outer (3-5 layers) are small and compactly arranged, each containing one inverted, cup-shaped chromatophore.

Tetrasporangia arising laterally on outer cells of inner cortex in which they are embedded, oval to pyriform, 85-140μ long, 50-60μ in diam., cruciate (divisions often irregular).

Nemathecia wart-like, pale pink, arising fortuitously on distal dichotomies. Male nemathecia sometimes covering entire surface of distal dichotomy, consisting of much branched filaments bearing spermatangia in both lateral and terminal positions. Female nemathecia smaller than the male, consisting of longer branched sterile filaments and shorter sparsely branched filaments terminated by carpogonia. Nutritive auxiliary cells intercalary in sterile filaments.

Carposporophyte embedded in nemathecium and consisting of a branched gonimoblast which develops from the fertilized carpogonium and fuses with several auxiliary cells in succession, and bears towards the outside of the thallus several ovoid to spherical gonimolobes.

Chromosome number = 68-72 (Rao)
Tetrasporangia, I-XII (in British Isles)
Sexual reproductive organs, VIII-X or XI?
Carposporophytes, X-I.

Occurring on rocky and other stable saxicolous substrata, often where there is a thin covering of sand. In the lower mid-littoral and sub-littoral regions.

Distributed generally wherever suitable habitats occur. From Faroes and Finmark to N. France, rare in Baltic; Labrador to Long Island.

Rao, 1956.

Legend for figure. Habit of female thallus with nemathecia, (x 1/2); T.S. thallus with nemathecium containing gonimolobes, (x); tetrasporangium, (x); male nemathecial filament, (x); female nemathecial filament terminated by carpongonium, (x).

K.M. Drew.

DERBESIA

Solier 1847.

Solier, 1847, p. 157.
Halicystis Areschoug, 1850
Type species: *Derbesia marina* (Lyngb.) Sol.
Type locality: Quivig, Faeroes.
Location of type specimen: Bot. Mus., Copenhagen, (Not yet seen)

Plant dimorphic, consisting of a coenocytic, siphonaceous sporophyte and a coenocytic, vesicular gametophyte. Sporophyte comprising a prostrate system from which erect, branched siphons develop, septa in pairs, formed at the base of the branches; chromatophores parietal, numerous, with or without pyrenoids. Sporangia borne laterally on erect siphons, liberating numerous zoospores; zoospores uninucleate, with a ring of flagellae at the flattened anterior end.

Gametophyte dioecious, a spherical coenocyte attached by penetrating rhizoids; chromatophores parietal, numerous, with or without pyrenoids. Gametes biflagellate, of two sizes, formed periodically from localised regions of the upper part of the vesicle and liberated forcibly through pores.

Probably widely distributed in the British Isles; found throughout the Northern hemisphere. The genus contains a single species.

DERBESIA MARINA
(Lyngb.) Sol.

Lyngbye, 1819, p. 79.
Solier, 1847, p. 158.
Type locality: Quivig, Faeroes.
Location of type specimen: Bot. Mus., Copenhagen (Specimen collected by Hornemann for Lyngbye). Not yet seen.
Vaucheria marina Lyngbye, 1819, p. 79.
Bryopsis tenuissima De Notaris, 1843, p. 203.
Derbesia tenuissima (De Not.) Crouan, 1867, p. 133.
Gastridium ovalis Lyngbye, 1819, p. 72.
Halicystis ovalis (Lyngb.) Areschoug, 1850, p. 220.
Halicystis parvula Schmitz *nom. prov. in obs.*

Sporophyte forming extensive mats; prostrate system comprised of loosely interwoven branches attached to the substrate by lobed holdfasts; erect siphons 1 - 4 (-8) cm. high, 30 - 70μ diam., irregularly or dichotomously branched, the degree of branching showing considerable variation, the base of each branch having a small segment delimited by two transverse septa. Chromatophores parietal, numerous, either spindle-shaped or discoid, each chromatophore with 1 - 3, or without, pyrenoids. Sporangia scattered on the erect branches, solitary, ovoid, globular or pyriform, 150 - 250μ diam., subtended by a small segment and liberating up to 50 zoospores.

Gametophyte vesicular, 3-4 (-12) mm. diam., solitary or in small groups, attached by a branched or tuberous rhizoidal system up to 15 mm. long, perennial and embedded in the substrate, generally one of the calcareous algae. Vesicle shed seasonally at a specially defined abscission layer, a new vesicle being regenerated from below. Nuclei embedded in peripheral cytoplasm; chromatophores forming a layer adjacent to the central vacuole. Macrogametes 12 - 14μ x 7 - 10μ and microgametes 7 - 8μ x 2μ formed at regular intervals. Zygote germinating to give protonematal structure which creeps over substrate and effects penetration.

Sporophyte either epiphytic or on mud, gametophyte either epiphytic on calcareous algae or saxicolous. Sporophyte in mid- to sub-littoral, gametophyte in sub-littoral regions. Both recorded from a number of isolated localities, probably not uncommon in Britain. From Finmark to Canary Islands; possibly occurring on both Atlantic and Pacific coasts of North America.

The form of the sporophyte varies with latitude, as a result of which two species have been recognised, *D. tenuissima* (De Not.) Crn., ranging from the Canary Islands to the south coast of Britain, and *D. marina* (Lyngb.) Sol., in the more northerly regions. Hamel (1931) states that the separation is extremely difficult and at present there would seem to be no clear-cut characters by which to distinguish the two species. We have therefore treated them as geographical modifications of a single species. This implies that *Halicystis ovalis* and *H. parvula* are also synonymous.

Kornmann (1938): Hollenberg (1935) : Kuckuck (1907).

Legend for figure: Thallus with sporangia (x10); Sporangium (x35); Zoospore (x330); Gametophyte (x10).

E.M. Burrows
P.S. Dixon.

Since the preparation of the above description, Dr Drew-Baker has directed our attention to a recent paper by Magne (*Bull. Soc. Bot. Fr.*, **103** (1956)) which offers some evidence for the existence of two species of *Halicystis* on the coast of Brittany.

E.M.B.
P.S.D.

A PRELIMINARY CHECK-LIST OF BRITISH MARINE ALGAE

Corrections and Additions II

1956

As in Phycological Bulletin no. 4, corrections and new records for the Preliminary Check-List (Parke, 1953) are now recorded. The page numbers quoted refer to the pages of the Check-List.

p. 498. Genus *Stichococcus*: replace species name *cylindricus* Butcher by *bacillaris* Naeg. (see George, 1957).

p. 499. Genus *Cladophora*: (a) ? *balliana* Harv.: add below *blidingiana* Kylin. (see Blackler, 1956).
(b) ? *traillii* (Batt.) Batt.: see note in Blackler, 1956.

p. 503. Genus *Feldmannia*: delete *battersii* (Born.) Hamel. (see Kuckuck, 1956).
Genus *Kutzingiella* Kornm.: add new genus after genus *Herponema*.
battersii (Born.) Kornm. (See Kuckuck, 1956).

p. 504. Genus *Stictyosiphon* (corrections by Dr M. Naylor):
This genus should now read:

Stictyosiphon Kütz., 1843.
tortilis (Ruprecht) Reinke (includes
S. subarticulatus (Aresch.) Reinke)
soriferus (Reinke) Rosenv.
griffithsianus (Le Jol.) Holm. et Batt.
(*Phloeospora brachiata* Born.)

p. 506. Genus *Chaetopteris*: delete genus and species (see Irvine, 1956 and his refs. to Waern, 1945 and Lund, 1950).
Genus *Sphacelaria*: (see Irvine, 1956).
This genus should now read:

Sphacelaria Lyngbye, 1819.
bipinnata (Kütz.) Sauv.
britannica Sauv.
caespitula Lyngb.
furcigera Kütz.
hystrix Suhr in Reinke
pennata (Huds.) Lyngb.
(*cirrosa* (Roth) Ag.)
var. *pennata*
var. *fusca* (Huds.) Irvine
plumigera Holm.
plumosa Lyngb.
(*Chaetopteris plumosa* (Lyngb.) Kütz.)
plumula Zanard.
racemosa Grev.
radicans (Dillw.) Ag.
? *saxatilis* Kuck. emend. Sauv.
tribuloides Menegh.

p. 513. Genus *Rhizoglossum*: replace genus and species as follows: (see Papenfuss, 1956).
Radicilingua Papenfuss, 1956
(*Rhizoglossum* Kylin, 1924)
thysanorhizans (Holm.) Papenf.

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REVIEWS

KYLIN, HARALD. *Die Gattungen der Rhodophyceen.* Pp. 673, with 458 text-figures. G.W.K. Gleerup, Lund. 1956. Price 135 Sw. Kr.

A review of this book is appearing elsewhere, but it is fitting that its publication should be welcomed by members of the British Phycological Society, as indeed it will be by phycologists throughout the world. In the main, this book is a compilation based on Kylin's previous publications on the Rhodophyta; but, even for those fortunate enough to possess some or all of these, it is of great value to have the material gathered together in the appropriate order in one volume. The arrangement is primarily on a taxonomic basis, following a general introductory section, and so the details of vegetative structure and reproduction are juxtaposed. This is in contrast to the arrangement of much the same material in *Anatomie der Rhodophyceen* of 1937 where consideration of vegetative structure found in the various families is followed by a similar section on reproduction and, to this reader at least, the new arrangement seems the better. Essentially, it is that found in volumes of the Pflanzenfamilien, for which series this book was planned originally.

Having worked so extensively on the development of the carposporophyte of the Florideae and having adjusted the classification on the basis of the development and structure of this phase, it is to be regretted that Kylin did not include a general comparative survey of this characteristic phase of this group of algae. A comparative survey of the construction of the thallus would have also been valuable.

Although a manuscript existed in 1944, the work was not ready to hand to the publishers at the time of Kylin's death in December 1949. Realising that new work could not endlessly be incorporated in the text, a supplement had been planned but existed in the form of unworked notes only at the time of his death. This was faithfully completed by his wife, Elsa Kylin, and forms a very valuable addition to the book. It is a further tribute to her devotion that she has so successfully completed the formidable task of transforming the manuscript into a published book, which will remain a standard book of reference on the Rhodophyta for a long time.

K.M. Drew.

SKUJA, H. *Taxonomische und biologische Studien über das Phytoplankton Schwedischer Binnengewässer. Nova Acta. Soc. Sci. Upsal.* Ser. 4., 16 (3). 404 pages and 63 plates.

Once again Dr H. Skuja has produced a massive paper on the plankton of some Swedish lakes and this too is worthy of the highest praise. The hundreds of illustrations are so beautiful that one can sense the artistic pleasure he must have enjoyed in making them. Apart from plankton algae of familiar type, he describes many bacteria of relatively large size or striking morphology and colourless filamentous members of the Cyanophyta (I use his terminology throughout). Some, at least, of the latter are not uncommon in several British lakes and perhaps we may hope that now they will be named. These algae are characteristic of the deeper deposits of lakes, or of the plankton of the hypolimnion too if more or less anaerobic conditions prevail. He groups them in a new order *Pelonematales*, with one family *Pelonemataceae*. In the introduction and elsewhere he discusses the relationships of many of the bacteria recorded. He does not agree with Professor E.G. Pringsheim and others who regard *Achromatium* and *Beggiatoa* as colourless genera of the Cyanophyta. As in his previous work (*Symb. bot. Upsaliens* 9 (3), 1948) he places a number of colourless flagellates (Polymastigineae and Hypermastigineae, close to the motile green algae (Volvocales sensu Fritsch). Many new taxa are described and among other interesting discussions he gives his reasons for considering *Planctomyces* Gimesi to be a bacterium and not a fungus, transferring *Schizochlamys delicatula* W. West to the Chrysophyceae (*Stichogloea delicatula* nov. nom.), and retaining the name *Coelosphaerium naegelianum* Ung. against *Woronichinia naegeliana* (Ung.) Elenkin. He also figures the swarmers of *Glaucocystis nostochinearum* Itz. for which he has erected the division Glaucophyta. The work closes with sections on the organisms (Synplankter) which live on or within the mucilage of planktonic algae, especially species of Cyanophyta; the planktonic communities of the hypolimnion, often so characteristic of meromictic lakes, and the winter plankton of Swedish lakes.

J.W.G. Lund.

REPORT **The Freshwater Biological Association:** report for the year ending 31st March 1956. Pp. 65. Price to non-members 3s. 0d.

The twenty-fourth annual report of the Association for the year ended March 31st 1956 includes descriptions of several researches which may be of interest to phycologists. Chemical studies include information on the effect of rain on the rocks in the English Lake District. The view is put forward that the differences in the composition of the surface waters in the area are related to differences in the erosion rate rather than the chemical composition of the rocks they drain. Even the supposedly acidic Borrowdale volcanic series contains considerable amounts of calcite, and the lack of calcium in the waters from these rocks is attributed to the formation of a surface layer from which calcium has been removed by cationic exchange, and which resists further solution and is not easily removed by erosion. Further progress has been made in the search for the substance or substances in soil extracts which promote the growth of *Asterionella* and other plankton algae. Extracts have been made which on evaporation yield glassy solids capable of promoting growth in concentrations of about 6 mg/litre, but these are clearly impure. It is, consequently, of interest that carbon analyses are now being made on waters from lakes in which *Asterionella* occurs, the carbon concentration varying from 0.5 to 5.0 mg/litre.

A start has been made in determining the standing crop of the smallest nannoplankton and a simple counting chamber devised. An interesting find has been a species of *Chrysochromulina* similar to those found in the sea by Dr Parke of the Marine Biological Association and in the process of description by her and Professor Manton of Leeds University. A beginning has also been made in growing some green planktonic algae for experimental purposes. Work is being carried out for a waterworks undertaking to estimate the potential fertility of the streams flowing into the largest of its reservoirs. It is hoped to obtain information which may help them to reach a decision on whether the agriculture carried out in the drainage area can be intensified without encouraging large growths of algae, with the consequent necessity of installing expensive extra filtration apparatus. Stream algae are under investigation with special reference to the effects of drought, floods and grazing by invertebrates. The relationship between the occurrence of fungal epidemics and the density of the host population *(Asterionella)* is discussed.

The botanical work of the Pollution Unit, now stationed at the Water Pollution Research Laboratory, Stevenage, has covered the periodicity of the algae in a sewage effluent and the river into which it flows. Estimations have been made of the amount of light reaching these algae using the well-known technique of submerging glass slides. The growth of *Stigeoclonium* spp. has been followed by direct observation of natural populations and by culture experiments. The work of this unit has not been confined to algae, for preliminary calculations of the abundance and oxygen production of *Potamogeton pectinatus* are recorded as part of the general consideration of the amount of oxygen produced in the sewage effluent by plants.

The report closes with the usual list of published works.

J. W. G. Lund.

KOSTER, JOSEPHINE TH. **Type Collection of Algae.** *Taxon*, 6 (2), 49-54. 1957.

In publishing this list of algal herbaria of the world, Miss Koster points out that it is based mainly on a list published in 1954 in Bulletin no. 2 of the British Phycological Society. The present list includes information given by Dr F. Drouet, Dr G.F. Papenfuss and Dr H.B.S. Womersley, as well as data taken from the lists of Miss C.I. Dickinson and Miss L. Newton (Mrs. Irvine) in Phycological Bulletin no. 1. (1952). Abbreviations for the different herbaria used in this list are in conformity with usage in *Regnum vegetabile*, vol. 6: **Index Herbariorum**, 3rd. Ed. 1956. Pt. I **The Herbaria of the World**, compiled by J. Lanjouw and F.A. Stafleu and published by the International Bureau for Plant Taxonomy and Nomenclature of the International Association for Plant Taxonomy.

M. Parke.

TREMAINE, MARIE (Ed.) **Arctic Bibliography** pub. by the Department of Defense, Washington. Vols 1-3 (1953), 4 (1954), 5 (1955), 6 (1956).

As the Phycological Bulletin will no longer publish lists of algal literature, it may be useful from time to time to consider sources of algal bibliographies. Among such, **Arctic Bibliography** calls for attention.

The six volumes (prepared for, and in co-operation with, the Department of Defense under the direction of the Arctic Institute of North America) contain abstracts of some 38,410 publications, covering most aspects of knowledges of the Arctic; and the series will be continued at the rate of one volume per year. **Arctic Bibliography** is arranged in two sections: (a) abstracts, arranged in alphabetical order of authors' names, and (b) comprehensive subject indexes of these publications, with algal references conveniently listed under "Algae". There are many cross-references throughout.

The work is particularly useful as a source of references to papers in the Russian language: Russian titles are transliterated and translated into English; and the abstracts are in English throughout the work.

Arctic Bibliography is not readily available in Britain, but the libraries of the following institutions are known to contain copies: Freshwater Biological Association, Ferry House, Ambleside, Westmorland; National Institute of Oceanography, Wormley, Surrey; Scott Polar Research Institution, Cambridge, and the Marine Station, Millport, Isle of Cumbrae.

H. T. Powell.

LETTERS TO THE EDITOR

CODIUM ON THE COAST OF NORTHUMBERLAND

In 1860 Brady recorded *Codium tomentosum* (Grev, as among "the rejectamenta of the sea on the coast of Durham, but neither he nor Batters (1888) list *Codium sp.* as growing on the north east coast of England. During the autum of 1949 a few small plants of *Codium sp.* were sent to me from Berwick-on-Tweed. While on the Inner Farne Island in the spring of 1952 two pools were found each lined with small plants of *Codium sp.* These pools were high up in the splash zone, but as they were adjacent to the Churn (a waterspout, they were splashed with fresh sea water at each high tide. Plants from both the above localities were subsequently identified by Dr P. Silva (1955) as *Codium fragile* (Sur.) Hariot Subsp. *atlanticum* (Cotton) Silva, n. comb.

By 1956 *Codium* is still colonising the same pools on the Inner Farne, although it has not been found elsewhere on the island. But plants of the same species have been recorded each year at scattered localities along the Northumberland coast and by the spring of 1956 as far south as St. Mary's Island, Whitely Bay. Here the plants are in shallow pools near high water mark, and although their distribution is restricted to a few pools the plants are numerous and seem well established. These records suggest that *C. fragile* subsp. *atlanticum* is a recent arrival on the north east coast and that it is spreading rapidly south along the coast of Northumberland.

Dept. of Botany,
King's College,
University of Durham,
Newcastle-upon-Tyne.

Betty Moss.

1st February 1957.

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SILVA, P. (1955). The dichotomous species of *Codium* in Britain. *J. mar. biol. Assoc. U.K.*, **34**, 565 - 577.

SOME UNCOMMON FRESHWATER ALGAE

1. *Thorea ramosissima* **Bory.**

Thorea ramosissima Bory. is a fresh-water member of the Florideae and occurs in flowing water in various parts of the world. It is apparently not uncommon on the continent of Europe but has so far been recorded in only one locality in the British Isles, a number of specimens having been taken from beside the bridge at Walton on Thames during the period 1846-1848. A recent search for the alga at Walton was unsuccessful.

During September, 1956 this alga was found to be locally abundant at King's Weir near Nazeing on the River Lee, Essex (National Grid reference TL 374052). Since then it has been found at a number of locks and weirs between Ware and Enfield. It was most abundant at King's Weir, where a large number of plants were growing on the apron of the weir. The longest plant recorded measured 57 cm. from base to apex.

In a number of places *Thorea* was found both above and below locks; but in two instances it was not associated with a lock or weir and one of these was in almost still water. All the plants were attached to wood, concrete, or to the iron uprights of bridges. None was attached to moss plants, in contract with some of the Walton specimens, which were epiphytic on *Fontinalis*.

Large numbers of monospores were being produced by all the plants investigated in September and October; but by the beginning of February none were apparently being produced.

Monospores from the *Thorea* have been germinated and further investigations on the life history and ecology of this alga are being made.

2. *Chroothece richterianum* **Hansg.**

According to Israelson (1949) there are probably only three good species of *Chroothece*, *C. mobilis* Pascher and Petrova, *C. rupestris* Hansg. and *C. richterianum* Hansg., and size is the only well defined character separating them.

During April 1956 a pure collection of a species of *Chroothece* was taken from the surface of a cliff at Fleshwick Bay, Port Erin, Isle of Man. Fresh water trickled continuously down the cliff face and there were also rich growths of diatoms and blue-green algae.

The living cells possessed a large central pyrenoid and a radiating stellate chromatophore of a blue-green colour, but both these became very difficult to see after the material had been preserved. Each cell had a strand of mucilage developed from one side which was visible without staining. Cells varied from 10-21 μ long and 8-12 μ wide excluding the thick cell wall, or 22-32 μ long and 16-20 μ wide including the wall. These figures agree with Hansgirg's material of *C. richterianum* and of five other collections of this species listed by Israelson, and lie outside Hansgirg's figures for *C. rupestris* and those of Pascher and Petrova for *C. mobilis*. All these figures have been taken from Israelson.

Apart from Central Europe there do not seem to be many records of species of *Chroothece*. West (1904) states that a form resembling *C. richterianum* but smaller (overall length 20-24 μ) has been observed in West Yorkshire on wet limestone rocks. This seems to be within the size range of *C. richterianum* but no further details or references are given. Apart from this there do not seem to be any other British records.

3. *Asterocytis* **sp.**

Filaments of a species of *Asterocytis* have been found growing epiphytically on *Cladophora* in a disused gravel pit in the Lee Valley and this is being further investigated.

University College,
University of London.

J.H.B. Belcher

Birkbeck College,
University of London.

Erica M.F. Swale

8th February 1957.

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SOME IRISH ALGAL FINDS

During a stay at the Lough Ine Biological Station four species of marine algae not recorded by Rees (1935) were found. These species were *Dudresnaya verticillata* (With.) Le Jol. (tetrasporophyte southeast corner of Castle Island), *Asparagopsis armata* Harv. (tetrasporophyte, in the same place and at the Station), *Crouania attenuata* (Bonn.) J. Ag. (at the Station and in the upper end of Barloge Creek), and *Rhizoclonium lubricum* Setch. & Gardn. in Gardn. = *Lola lubrica* (Setch. & Gardn. in Gardn.) A. & G. Hamel.

The latter species appears to be new to Britain (Parke 1953). It was collected on August 16th 1953 in the Goleen lying as loose masses on mud flats just emerged at low tide.

Doty (1947) thinks that *Rhizoclonium lubricum* may be referred to *R. riparium* (Roth) Harv. as a modification of that species. The constancy of the distinctive features as confirmed by this new find is not consistent with such an assumption. To illustrate this constancy some details may be of interest:

The author made a note about the *Spirogyra*-like habit so different from that of *R. riparium*, without remembering that this comparison occurred in the description of *R. lubricum*.

25 measurements gave an average width of 43.8 μ with 38 as the lowest and 51 as the highest value measured. The corresponding figures given by Setchell and Gardner (Gardner 1919) are 40 35 and 50 μ . For the length of the cells an average value of 149.9 μ was found, with a range of 81 - 227, while Setchell and Gardner give 1 - 6 times the width. In material from France, A. and G. Hamel (1929) found about the same cell dimensions, a good deal greater than those of *R. riparium* (Koster 1955).

The nuclei are found in a parietal position. 25 counts gave an average of 6.8 per cell, with a range of 3 - 16. Setchell and Gardner give no nuclear counts, but Hamel (1931) has counted between 5 and 16 with the same parietal position. Thus the Irish find confirms the statement based on French material, that nuclear characters provide a good distinction between the species in question and *R. riparium* the latter (also in material from Lough Ine) showing 1, 2 or 4 nuclei (rarely 8 in pairs, according to A. and E. Hamel) in an axile position.

Sincere thanks are offered to the Director of the Lough Ine Biological Station, Professor L.P.W. Renouf, for permission to work at the station, and for his never-failing help.

Botanical Laboratory of the University
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Tyge Christensen

March 6th 1957.

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THREE SPECIES OF VAUCHERIA NEW TO BRITAIN

A search for *Vaucheria dichotoma* (L.) Ag. in northern Kent, where the type specimen was collected in pre-Linnean times, failed to produce this species, * but showed the presence of three other species not previously known to Britain.

(1) *Vaucheria medusa* Christensen was found on May 26th 1956, growing together with smaller amounts of *V. debaryana* Wor., *V. sessilis* (Vauch.) DC., and *V. compacta* (Coll.) Coll. ex Tayl. under *Oenanthe crocata* L. on the western bank of the river Medway between New Hythe and Snodland, N.W. of Maidstone. The plant was sterile, but fruited abundantly in a crude culture. *V. medusa* has formerly been found in Sweden, Denmark, Germany (Rieth 1956), and Holland (Zonneveld 1957).

(2) *Vaucheria sescuplicaria* Christensen and (3) *V. erythrospora* Christensen were found on the same day, growing together with *V. intermedia* Nordst. on clayey ground with some specimens of *Aster tripolium* L. on the north-facing verge of the road between Stoke and Grain, E.N.E. of Rochester, sloping down towards a partly flooded strip of ground between the road and the railway line. Both species were brought to fruiting in a crude culture. *V. sescuplicaria* is previously known from Sweden, Denmark, Germany, France, Spain and Algeria, and *V. erythrospora* from Sweden, Denmark and Germany (Christensen 1956).

Botanical Laboratory of the University — Tyge Christensen
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March 6th 1957.

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*The author would be very glad to receive any living material of *Vaucheria dichotoma* from this area. Collectors willing to help are asked to write to the above address for a container and instructions for packing. The author will be away from Copenhagen until September; but the species will keep alive for months if kept in a dish away from direct sunlight.

GRACELARIA ERECTA

Recent observations suggest forcibly that *Gracelaria erecta* Grev. (= *Cordylecladia erecta* (Grev.) J. Ag.) is an extreme form of *Gracelaria verrucosa* (Huds.) Papenf.

This suggestion can only be verified by following spore development to maturity, a feat probably difficult of accomplishment. Meanwhile, phycologists, particularly those collecting on the south coast, are asked to report any plants which fit the usual description of *G. erecta*. Specimens, either herbarium ones or fixed in 1:3 acetic-alcohol, will be gratefully received; and collectors are especially asked to record the ecological conditions and the time of year when the specimens were gathered.

Marine Biological Station, W. Eifion Jones
Anglesey,
North Wales.
6th March 1957.

REQUEST FOR RESEARCH MATERIAL

Dr Elizabeth E. Percival, Dept. of Chemistry, West Mains Road, Edinburgh, 9, Scotland, will be grateful to receive fairly pure samples of the following two algae for chemical investigations:

(1) *Acrosiphonia centralis (Cladophora arcta)*: a total amount of 1 kg. of dried weed is required, but smaller quantities will be very much welcomed. Collectors are asked to rinse the weed in sea water and to dry it in a current of air (not in a closed atmosphere) at 60°C. before dispatch.

(2) *Cladostephus verticillatus* or *C. spongiosus*. Up to 500 gms. of dried weed are required; but again, smaller amounts will be received with gratitude.